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CANINE 2D ECHOCARDIOGRAPHY - STANDARD VIEWS

ECOCARDIOGRAFIA 2D LA CÂINE - SECȚIUNI STANDARD

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ABSTRACT | REZUMAT

Echocardiography is the tool which allows a proper characterisation of the heart morphology, being a mandatory diagnostic procedure in cases suffering from heart disease. Echocardiography implies a specific protocol of investigation. As a standard protocol, the heart is scanned from the right side (parasternal long-axis and parasternal short-axis sections) and from the left (parasternal apical sections). Right parasternal long-axis images are: left ventricular five-chamber view (left ventricular inflow-outflow tract) and four-chamber view. Right parasternal short sections are: the left ventricle with papillary muscles, left ventricle at chordae tendinae, left ventricle at mitral valve, heart base and aorta and heart base and pulmonary artery. Standard left parasternal apical views are: apical five-chamber view and apical four-chamber view. As a drawback associated with echocardiography, we can mention the cost of high-quality ultrasound machines and the necessity of a good echocardiographic expertise.

Key words: echocardiography, dog, canine, heart

Examenul ecocardiografic este investigația care permite caracterizarea morfologiei cardiace. Fără o evaluare ecocardiografică, examenul cardiologic este incomplet. Examenul ecocardiografic se realizează după un protocol standard, astfel, toate structurile cardiace să fie investigate. Evaluarea ecocardiografică va evalua cordul din secțiune longitudinală, transversală sau apicală, fie de pe partea dreaptă, fie de pe partea stângă a toracelui. Secțiunile standard din planul lung sunt: patru și cinci camere iar în planul scurt: la nivelul mușchilor papilari, la nivelul cordajelor tendinoase, la nivelul valvei mitrale, la nivelul bazei cordului și a arterei aorte și la nivelul bazei cordului și a arterei pulmonare. Secțiunea apicală de pe partea stângă implică evaluarea cordului din secțiunea patru și cinci camere. Ca neajunsuri asociate ecocardiografiei putem menționa costul ridicat al ecografelor de calitate și necesitatea unei bune expertize ecografice care se obține în timp.

Cuvinte cheie: ecocardiografie, câine, canin, inimă

Echocardiography is the diagnostic tool which provides valuable information regarding the heart structures (2D echography). For a complete heart evaluation, the Doppler exam is an essential part of the examination. Doppler exam provides information regarding the blood flow direction, velocity and character (laminar or turbulent). There is also a new type of Doppler, called tissue Doppler (TDI) which offers information about the velocity of the myocardial movement throughout the cardiac cycle. Speckle-tracking echocardiography is the newest feature on the ultrasound machines, and this feature permits the quantification of the myocardial deformation. 3D echocardiography also provides new perspectives for cardiac imaging. Before starting the investigation, it is recommended to clip the thorax on the right and left side (3rd to 6th intercostal spaces). In animals with poor hair coverage, applying a large amount of acoustic gel/isopropyl alcohol is usually enough to obtain good quality images (1). To increase the accuracy of the images, the patient is restrained in lateral recumbency, to minimise the effect of air on sound transmission. The heart is scanned from ventral, the animal being positioned with the thorax over a cut-out table. This way, the heart drops down reducing the interference of the lungs (air) on echographic images. If the animal presents dyspnoea, lateral recumbency could be fatal. In this situation the animal is scanned while standing, but this technique requires a higher level of expertise.

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RIGHT PARASTERNAL LONG AXIS VIEWS

Right parasternal four-chamber view

For obtaining the right parasternal four-chamber view the probe is placed on the right thorax, at the level of 4th or 5th intercostal spaces or where the apex beat is easily identifiable and the probe faces caudally (1). The probe's marker is directed toward the spine. Usually, the beginners place the probe close to the sternum. In this situation only the ventricles are visible on the echographic view. To correct this, the probe needs to slide dorsally on the thorax towards the spine. This section allows the characterisation of the ratio between the chambers and walls. In this view we

can see (the near field): right atrium and the right ventricle and below (the far field): the left atrium and the left ventricle (Fig. 1). Normally, the right ventricle chamber is 1/3-½ of the left ventricle chamber, while the right ventricle free wall (anterior wall) is 1/3-½ of the left ventricle free wall (posterior) (2). In this section, the right atrium seems smaller compared with the left atrium, but there are situations when the atria dimension is similar and that is can be a normal feature. The tricuspid valve and mitral valve should be found at the same level.

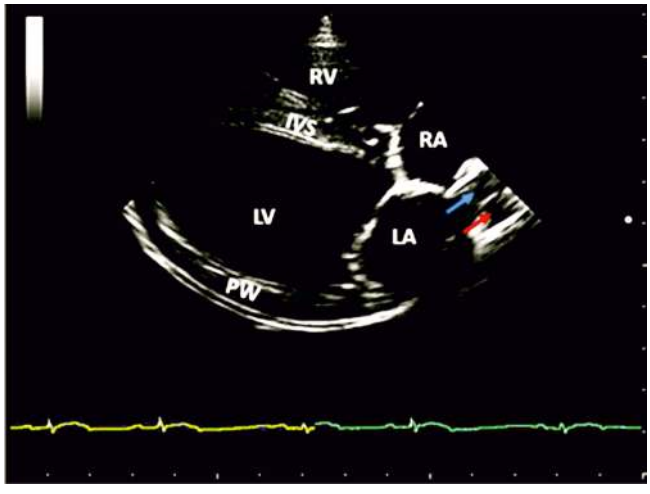

Fig. 1. Right parasternal four-chamber view (RV-right ventricle, RA-right atrium, LV-left ventricle, LA-left atrium, IVS-interventricular septum, PW-left ventricle posterior wall, the blue arrow-right pulmonary vein, the red arrow-right main pulmonary artery)

The lack of atrioventricular valves alignment is characteristic for mitral/tricuspid dysplasia. Inside the left atrium, at the level of the superior left atrium wall the right pulmonary vein and right main pulmonary artery are visible. Normally, these two structures have the same diameter in dogs (0.85-1.1). When the diameter of the vein is larger than the artery diameter a high pressure within the left atrium must be suspected (3). When the artery diameter is higher, pulmonary hypertension should be ruled out. This view is not ideal for the Doppler examination of the atrioventricular valves, but colour Doppler will help with the diagnosis. The pericardium is visible as a hyperechoic (bright) line. Sometimes, the coronary sinus is visible over the left atrium wall. Normally, this vein is not visible. High right atrium pressure or the persistence of left cranial vena cava make this vein visible (Fig. 2).

This view permits the evaluation of the left ventricle volume, which is extremely important for the diagnosis of DCM. Also, from this view, the M-mode can be generated. Doppler imaging of the inter-atrial septum is feasible due to perfect alignment of the ultrasound beam and abnormal flow in case of atrial septal defect.

E-point-to-septal-separation, which is a parameter that allows the estimation of the left ventricle dimension could be also evaluated from this view.

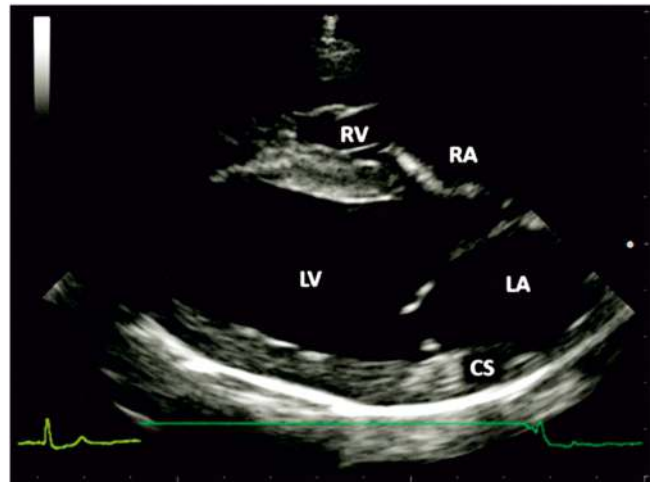

Fig. 2. Right parasternal four-chamber view underlying the coronary sinus (RV-right ventricle, RA-right atrium, LV-left ventricle, LA-left atrium, IVS-interventricular septum, CS-coronary sinus)

Right parasternal five-chamber view (left ventricle inflow-outflow view)

To obtain this view, the probe is slightly rotated counterclockwise. The chambers visible in this section are: right atrium, right ventricle, left atrium, left ventricle and aorta (Fig. 3).

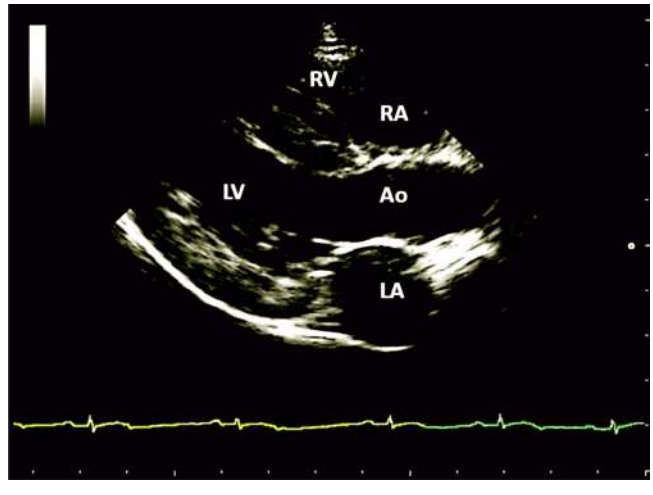

Fig. 3. Right parasternal five-chamber view (RV-right ventricle, RA-right atrium, LV-left ventricle, LA-left atrium, Ao-aorta)

The left atrium is smaller in this view compared with the previous section due to the presence of aorta, aortic cusps and left ventricle outflow tract (3). Mitral and tricuspid valves are visible and should be situated at the same level. This view allows the diagnosis of the peri-membranous ventricular septal defect, which is

usually located below the aortic cusps. M-mode can be generated from this view and the evaluation of the left ventricle volume is also feasible. Doppler exam of the atrioventricular valves and aorta is possible but due to less than ideal alignment between ultrasound beam and flow direction the result is usually underestimated.

Right parasternal short axis views

There are five standard sections from the right parasternal short axis: the left ventricle, the cordae tendinae, the mitral valve, the heart base with aorta and the heart base with pulmonary artery.

1. The left ventricle – this section is at the level of the papillary muscles (Fig. 4).

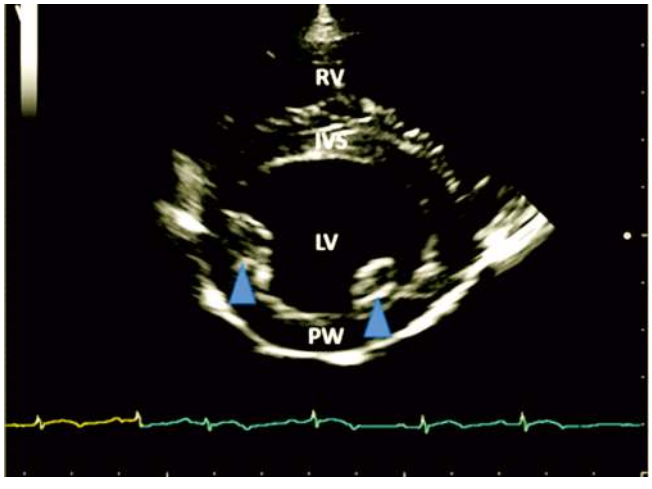

Fig. 4. Parasternal short axis view at left ventricle with papillary muscles level (RV-right ventricle, IVS-interventricular septum, LV-left ventricle, PW-left ventricle posterior wall, the blue arrow heads-papillary muscles)

The right ventricle is positioned in the top of the image and has a crescent shaped. The interventricular septum is convex with the convexity toward the right ventricle (the chamber with lower pressure). Flattening of the interventricular septum is a sign of high right ventricle pressure (pulmonic stenosis or pulmonary hypertension). The left ventricle has a mushroom shape, imagine that is induced by the papillary muscles. The right ventricle free wall should be 1/3- ½ of the left ventricle free wall (1). In this view M-mode could be generated for specific and precise measurements of the left heart. Subjectively, left ventricle contractility could also be evaluated from this section (contractility depends on many variables).

2. The cordae tendinae – this is an upper section of the heart (Fig. 5). All the structures mentioned above are also visible here. The right ventricle diameter is higher compared to the previous one. The left ventricle is more rounded and cordae tendinae appear as hyperechoic structures. M-mode could also be generated here.

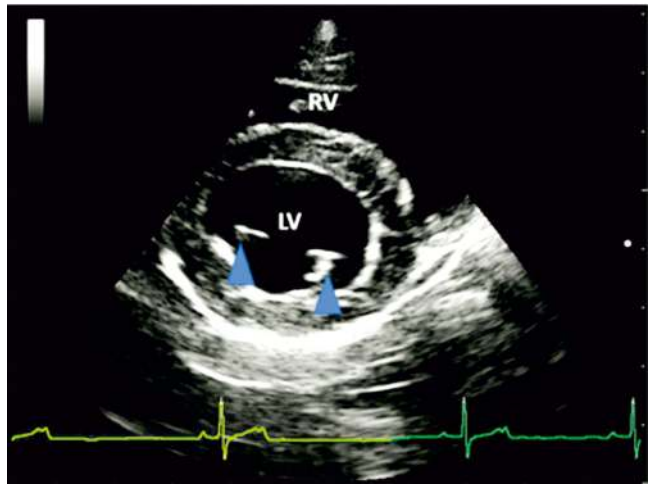

Fig. 5. Parasternal short axis view at the cordae tendinae level. The left ventricle chamber is more rounded compared the previous section and chordae tendinae appear as a hyperechoic structure (the blue arrow heads-cordae tendinae)

3. The mitral valve – it is the third crossed section of the heart. Both mitral leaflets are visible as hyperechoic structure. This section is also called "the fish mouth", an aspect that is induced by the movement of the mitral cusps in systole and diastole (1). This view permits the evaluation of E-point-to-septal-separation, as a marker of left ventricle distension.

4. The heart base and aorta – this is an extremely important view that allows the evaluation of the left atrium dimension (Fig. 6).

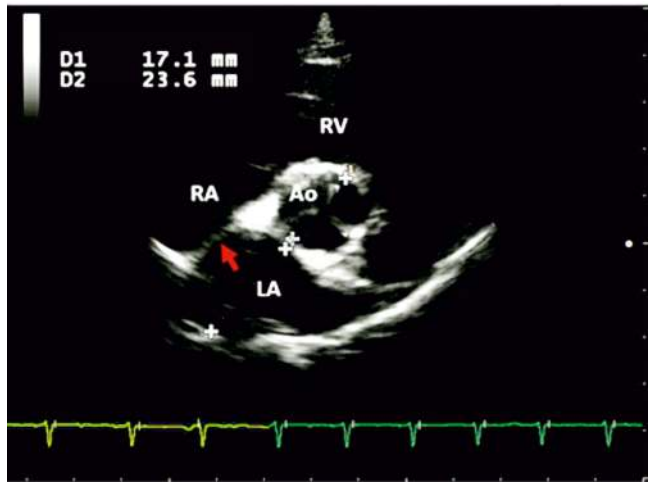

Fig. 6. Parasternal short axis view at the heart base and aorta level (RV-right ventricle, RA-right atrium, LA-left atrium, Ao-aorta, the red arrow-interatrial septum)

Currently, this view is the most used method which offers information regarding the severity of left atrium dilation. Myxomatous mitral valve disease and dilated

cardiomyopathy are frequently associated with left atrium dilation. When compared to the aorta, the left atrium is less than 1.5x. Depending on the distension severity, the left atrium is 2x, 3x or even higher than aorta. When aortic cups are closed, the image generated resembles the Mercedes logo (1). Atrial septal defect and perimembranous ventricular septal defect could be identified with colour Doppler. Tricuspid flow also permits a good alignment with the ultrasound beam, Doppler exam being possible (2).

5. The heart base and pulmonary artery – this is the highest standard crossed section of the heart (Fig. 7). This view allows a proper Doppler evaluation of the pulmonary artery and pulmonary valve due to the good alignment of the pulmonary flow with the ultrasound beam. Pulmonary artery to aorta ratio is possible from this view. This ration is about 1. Pulmonary artery distension could be associated with pulmonary hypertension. Pulmonary artery bifurcation is also visible. The right pulmonary artery distensibility index, as a marker of pulmonary hypertension, is evaluated from this view.

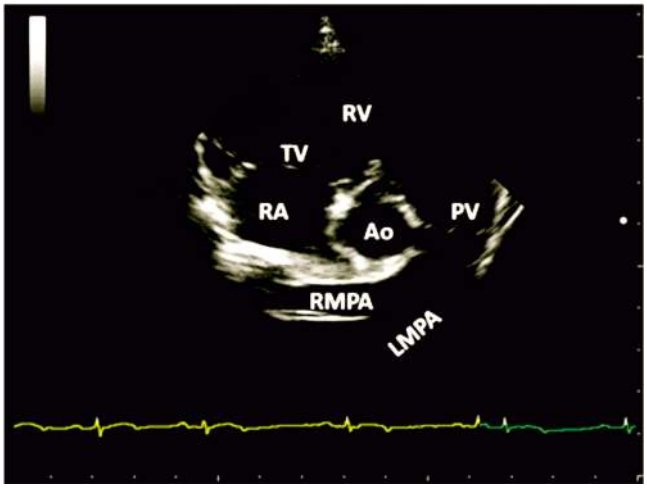

Fig. 7. Parasternal short axis view at the heart base and pulmonary artery level (RV-right ventricle, RA-right atrium, Ao-aorta, TV-tricuspid valve, PV-pulmonary valve, RMPA-right main pulmonary artery, LMPA-left main pulmonary artery)

APICAL VIEWS

These views permit a perfect alignment for Doppler interrogation of the atrioventricular, aortic and pulmonic valves. There are 2 standard views: apical four-chamber (left atrium, left ventricle, right atrium, right ventricle) and five-chamber views (felt atrium, left ventricle, right atrium, right ventricle and aorta) (1). In apical four-chamber view, ventricles are positioned in the top of the echographic image (near field) while atria are at the bottom (Fig. 8). For a good alignment of the ultrasound beam with the tricuspid flow, the left heart is not completely visible. These sections allow the estimation of left ventricle volume (Simpson's method of disc), measurement which is extremely useful in the diagnosis of dilated cardiomyopathy (3).

Sometimes, for a good alignment of the tricuspid valve with the ultrasound beam, the standard four-chamber view is modified and the left heart is incomplete visible. In apical five-chamber view, aorta is also visible, but the right heart (right atrium and right ventricle) is not entirely visible.

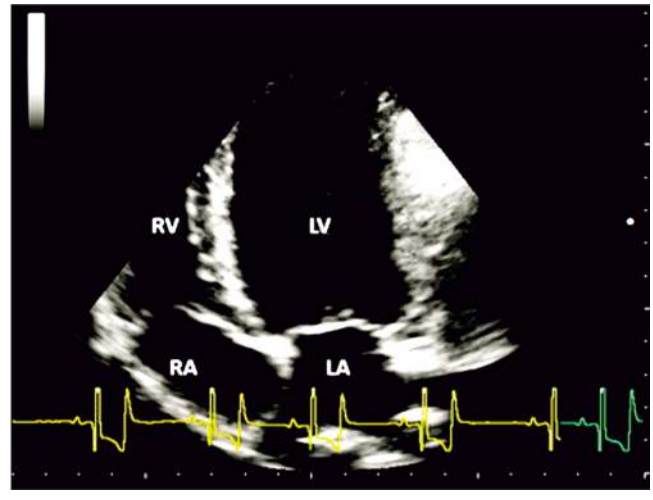

Fig. 8. Apical four-chamber view (LA-left atrium, LV-left ventricle, RA-right atrium, RV-right ventricle)

CONCLUSIONS

The 2D echocardiography is a non-invasive tool of investigation which provides accurate information regarding the thickness of the walls, the dimension of the heart chambers and leaflet morphology.

The 2D echocardiography is essential for heart pathology diagnosis. Unfortunately, the specialised ultrasound machines are expensive and the acquisition of the standard views needs a higher ultrasonographic expertise.

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