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Original Contribution

TRANSTHORACAL TWO-DIMENSIONAL ULTRASONOGRAPHIC ANATOMICAL STUDY OF THE HEART IN THE RABBIT (*Oryctolagus cuniculus*)

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ABSTRACT
PURPOSE: Researching of the rabbit heart by two-dimensional transthoracal ultrasonography in order to data about the heart imaging anatomy and diagnostics of this animal be given.
OBJECTS: Eight sexually mature, healthy New Zealand rabbits, aged 12 months with body weight from 2.8 kg to 3.2 kg were investigated.
METHODS: The animals were anesthetized and positioned in laying lateral left and right position. The trasducer was put in the places for imaging of standard planes from the heart image.
RESULTS: At the imaging of the heart in right parasternal plane on its longitudinal axis, the ascending aorta was visualized as a hyperechoic finding, surrounded by the close heart structures. The image from the left parasternal plane on the longitudinal axis of the heart showed the both left heart cavities. The parasternal plane on the short axis of the heart was a transversal image, and the valvular apparatus was visualized.
CONCLUSIONS: Our results demonstrated that the two-dimensional transthoracal ultrasonographic study of the rabbit heart is a completely noninvasive and enough definitive method about the qualitative estimation of the normal heart structures.

Key words: imaging anatomy, echocardiography, rabbit

INTRODUCTION

The rabbit heart is situated close to the sternum, and its longitudinal axis is almost parallel to the thoracic base and its topography is similar to this of the human and carnivore heart (1).

In 1984 (2) applies the transthoracal two-dimensional echocardiography in the dog. The author applies the transthoracal two-dimensional echocardiography and uses the experiment, performed in the man. The author uses left and right parasternal postion of the transducer about visualization the heart cavital parts and its valvular apparatus.

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The canine and feline heart is investigated by (3) via ultrasonography and they present recommended planes about transthoracal echocardiography of the carnivores' heart. The authors propose three postions of the transducer in connection with the projection of the heart image: right parasternal, left cranial parasternal and left caudal (apical) parasternal.

The feline heart is investigated ultrasonographically transthoracally by (4). According to the author the parasternal study of the heart on its short and longitudinal axis permits visualization of the heart cavities and valves.

The feline heart is researched by (5) with transoesophageal two-dimensional echocardiography. They find that this method is additive about heart investigation and is more detailed than the other imaging methods.

The obtained images of the long and short heart plane are similar to these in the dog.

A lot of authors (6) carry out transthoracal echocardiography and transabdominal echography on Göttingen minipigs. They observe the morphology of the heart and abdominal aorta. The authors find, that the ultrasonography, which is performed without sedation leads to discomfort and variety of the obtained values. The sedated minipigs are a suitable biological model in the experimental cardiological studies.

The transthoracal two-dimensional echocardiographic study in ponies and horses was made in the left and right 8th intercostal space about imaging of the long and short heart plane. The results demonstrate that there isn't correlation among the obtained quantitative values and the body weight in the animals with similar weight. There is a correlation between the measured quantitative parameters and the increasing of the body weight in the horse with big differences in the body mass (7-9).

A transthoracal echocardiographic investigation of the aortic ring is made by (10) in the sheep in order to its preoperative measurement before valvular experimental prosthesising.

Many authors (11) investigate ultrasonographically transthoracally the rabbit heart about the identification and measurement of the pericardial adipose tissue. The authors distribute the results about the interpretation of the adipose lesions in the man.

By the known, we can make a conclusion that the echocardiographic two-dimensional transthoracal study in the rabbit is necessary in order to heart imaging anatomical and diagnostic data of this animal be given.

MATERIALS AND METHODS

We investigated ultrasonographically transthoracally two-dimensionally 8 sexually mature, healthy white New Zealand rabbits, aged 12 months with body weight 2.8 kg to 3.2 kg. The studies were made in strict compliance with European convention for Vertebrate Animals, used for experimental purposes and other scientific aims (Strassbourg May 16th 1986, the Europen Convention for protection of the companion animals (Strassbourg November 13th 1987) and Law of the Animal Protection in the Republic of Bulgaria (division IV-Experiments with animals art. 26, 27 and 28, received at January 24th 2008 and populated in Officional Gazette № 13, 2008).

The animals were anesthetized with 15 mg/kg i m Zoletil® 50 (tiletamine hydrochloride 125 mg and zolazepam hydrochloride 125 mg in 5 mL sterile isotonic solution) Virbac, France. The study was made by ultrasonic equipment CHISON 600 VET (China) and multifrequent microconvex transducer with frequency 7 MHz and radius 20 mm. The findings were documented with termoprinter device Mitsubishi P91E. The hair was cut from the ventral and lateral thoracic wall in the region from manubrim sterni (cranially) to processus xiphoideus (caudally), and laterally to the right and left axillary region. About better contact between the transducer and skin, we used contacted gel (Eko-gel® Lessa, Espana). The two-dimensional echocardiography of the rabbit heart was made at laying left and right lateral position, and the transducer was put in the places for imaging the following standard planes of the heart image:

1. Left parasternal plane on the longitudinal axis of the heart, showing the initial way of the left ventricle, parts from the heart cavities e.t.c. (the transducer was inclined consecutively in the third and fourth left intercostal spaces, laterally from the sternum) (12).
2. Right parasternal plane on the longitudinal axis of the heart, demonstrating the four heart cavities, parts of them e.t.c. (the transducer was inclined consecutively in the third and fourth right intercostal spaces laterally from the sternum) (3).
3. Left parasternal plane on the short axis of the heart, showing the aortic valve, left and right ventricle in different levels e.t.c. (the transducer was inclined consecutively in the third and fourth left intercostal spaces, close to the sternum) (12).
4. Apical plane, showing the heart cavities (the transducer was inclined in the fifth intercostal spaces) (3, 12).
5. Right subcostal plane on the longitudinal axis of the heart, demonstrating the four cavities, parts from them e.t.c. (the transducer was put horizontally between the right costal arch and xyphoid process) (12).

RESULTS

At the imaging of the heart in the right parasternal plane on its longitudinal axis, the ascending aorta and aortic valve were

visualized as a centrally situated hyperechoic finding, surrounded by the hypoechoic left and right proventricles, parts of the right ventricle, pulmonary ostium, the beginning of the pulmonary trunk and pulmonary valve. The walls of the heart cavities were hyperechoic, compared to their lumen (**Fig. 1**). The beginning of the pulmonary trunk was on the left and cranially from the beginning of aorta, right ventricle and proventricle – caudally and on the right toward aorta, and the left proventricule – caudally to aorta. The pulmonary valve was visualized as a hyperechoic finding in front of the aortic beginning (**Fig. 1**).

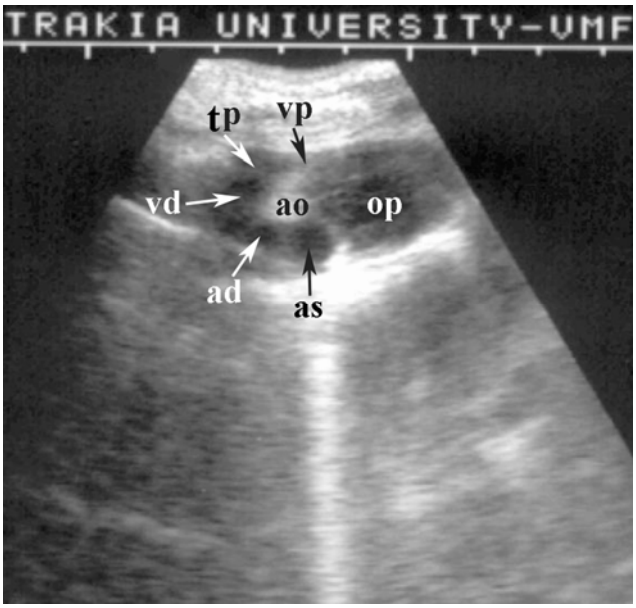

Fig. 1. Right parasternal plane on the longitudinal axis of the heart: ascending aorta (ao), pulmonary ostium (op), pulmonary valve (vp), pulmonary trunk (tp), right ventricle (vd), right atria (ad), left atria (as).

The overview image of the left parasternal plane on the heart longitudinal axis demonstrates the both left heart cavities, whose lumen is hypoechoic, and their walls – hyperechoic. The bicuspidal valve was visualized as a hyperechoic finding among the left ventricle and proventricle (**Fig. 2**).

Fig. 2. Left parasternal plane on the longitudinal axis of the heart: left atria (as), left ventricle (vs), bicuspidal valve (vbs).

The parasternal plane on the short axis of the heart is a transversal image, visualizing the

hypoechoic lumen of the ascending aorta – the last is situated centrally and peripheral were the visible elements of the heart cavities (**Fig. 3**). The beginning of the pulmonary trunk is on the left of aorta, and on the right – the hypoechoic parts of the right ventricle and proventricle. The left proventricle was visible behind the ascending aorta. The tricuspidal and pulmonary valves were identified (**Fig. 3**).

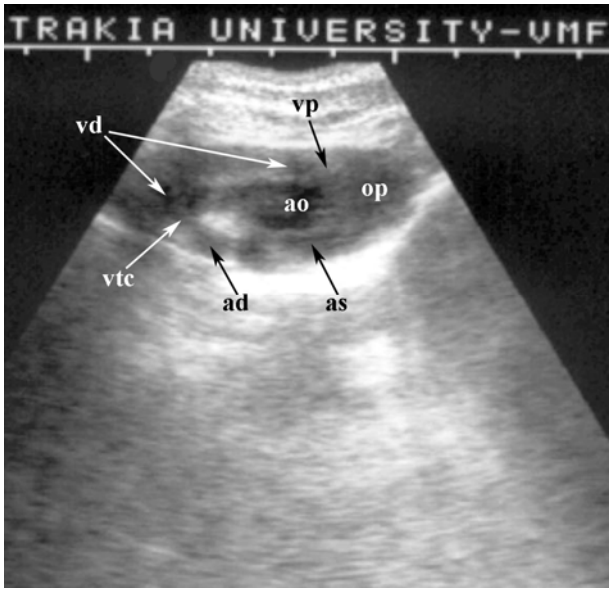

Fig. 3. Left parasternal plane on the longitudinal axis of the heart: ascending aorta (ao), pulmonary ostium (op), pulmonary valve (vp), right ventricle (vd), tricuspidal valve (vtc), right atria (ad), left atria (as).

In the investigation of the apical plane of the left apical part, the hypoechoic cavity of the left ventricle was found, surrounded by its hyperechoic myocardium (**Fig. 4**).

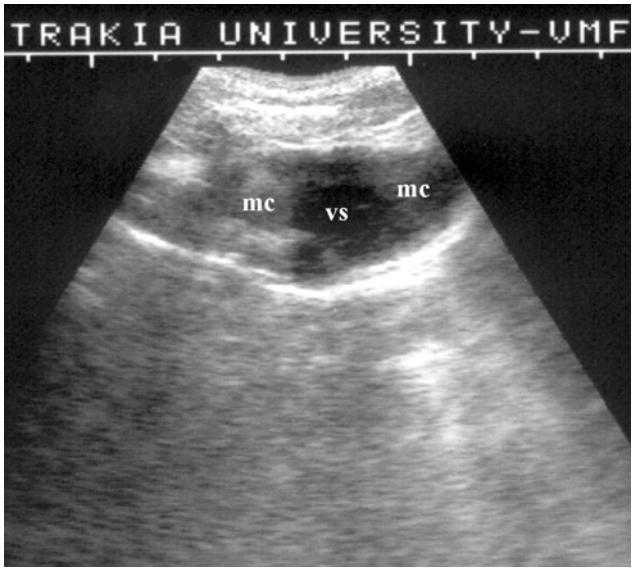

Fig. 4. Apical plane of the left ventricle's apical part: myocardium (mc), left ventricle (vs).

In the visualizing of the right subcostal plane on the longitudinal axis of the heart, the hypoechoic lumen of the right proventricle and the hypoechoic findings of the caudal vena cava and some of the hepatic veins were found (**Fig. 5**).

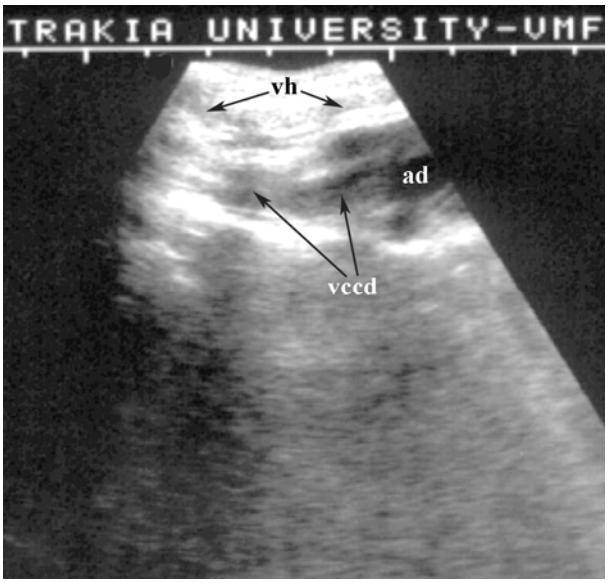

Fig. 5. Subcostal plane on the longitudinal axis of the heart: right atria (ad), caudal vena cava (vccd), hepatic veins (vh).

DISCUSSION

Our results showed, that the two-dimensional transthoracal ultrasonographic study of the rabbit heart is a completely noninvasive and enough definitive method about qualitative estimation of the normal heart structures. A lot of authors make transoesophageal two-dimensional echocardiography in dogs and cats and find that this method gives a complete information about the structure of the heart base (5, 13) and mediastinum (14), but it is more invasive than the transthoracal echocardiography.

The rabbit heart's topography, similar to this in the carnivores and man (1) motivated us to use a combination of approaches (2, 3, 12), typical for the two-dimensional transthoracal echocardiography in these mammals.

We made the transthoracal ultrasonographic investigation of the rabbit heart mainly in the intercostal windows of 3, 4 and 5 left intercostal spaces, and 3 and 4 right intercostal spaces, which is provoked by the cranial position of the rabbit heart (1), contrary to the horse, swine and sheep (6, 9, 10).

Like (2) and (3) about the carnivores, we recommend mainly three positions of the transducer for two-dimensional transthoracal echocardiographic study of the rabbit heart – left parasternal one on the longitudinal axis of the heart, right parasternal one on the longitudinal axis of the heart and left parasternal one on the short heart axis.

Our data are based on the qualitative and topographic characters of the rabbit heart, as the obtained data by (15) about the qualitative estimation of the heart structure in the rat and mouse. Contrary to (16), who find the diameter of the left ventricle, thickness of the interventricular septum and diameter of the aortic ring in anesthetized animals and compare them with these in intact ones, we studied only the quality of the heart image in anesthetized rabbits.

Like the data of (4) about the feline heart we propose the parasternal ultrasonographic investigation of the rabbit heart to be used about the sagittal and transversal two-dimensional visualization of the heart cavities and valves.

The results of the study correspond with the data of (6) about the echocardiography in Göttingen minipigs. We confirm that the echocardiography with sedation doesn't provoke clinical discomfort and difficulties of the images' anatomical interpretation.

The visualization of the rabbit's aortic beginning at right parasternal position on the longitudinal axis and at left parasternal one on the short heart axis can be used as a method about the preoperative estimation of the aortic

valve in experimental prothesising, as the experiment, proposed by (10) for the sheep.

The results of our study permit us to conclude, that the rabbit is a suitable biological model about the imaging anatomical and diagnostic research of the rabbit, in connection with resolving of some cardiological problems in the animals and man.

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