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# Standardization of the two-dimensional transcoelomic echocardiographic examination in the central bearded dragon (*Pogona vitticeps*)☆

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**Abstract** *Objectives:* To objectively and subjectively describe the normal spectrum of two-dimensional echocardiographic findings in the central bearded dragon (*Pogona vitticeps*).
*Animals:* Sixteen central bearded dragons.
*Methods:* Central bearded dragons were prospectively evaluated under manual restraint in right and left lateral recumbency to identify imaging planes for reproducible measurements of cardiac chambers, subjective two-dimensional analysis and color Doppler assessment.
*Results:* Echocardiography can be performed through windows in the left and right axillae. The window in the left axilla allows for a subjective and objective assessment of cardiac structure and function. The right axillary window allows for evaluation of pulmonary artery flow. Both views provide data for the presence of

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pericardial effusion or valvular insufficiency. With optimized imaging planes, cardiac chambers and fractional area change along with fractional shortening in the longitudinal and transverse planes can be calculated. Body weight and cardiac chamber dimensions of males were significantly larger than females. Ventricular fractional area change was the most consistent functional assessment. The majority of animals were found to have no evidence of valvular insufficiency, while approximately half had evidence of pericardial fluid. Pulmonary artery flow was assessed in all patients. Left and right aortic velocities cannot be reliably obtained. *Conclusions:* This study is the first to generate reference values for cardiac structure and function in clinically healthy central bearded dragons. Valvular insufficiency is not a normal finding in central bearded dragons, while mild pericardial effusion may be.


## Introduction

Central bearded dragons (*Pogona vitticeps*) are one of the most common reptile species kept as companion animals. Currently, there are few reports in veterinary medicine that have evaluated or developed normal ranges for reptile cardiac structure and function [1–3]. This lack of literature limits knowledge of the frequency and spectrum of cardiac disease in reptilian patients. Echocardiography is a valuable tool in assessing cardiac structure and function, as it is non-invasive and can be performed with minimal or no sedation [4–10]. Documentation of the normal cardiac structure and function in central bearded dragons therefore represents a clinically relevant goal for the veterinary profession.

The central bearded dragon heart lies at the pectoral girdle in the cranial coelomic cavity at the level of the forelimbs and in proximity to the gular region [11–18]. As in other non-crocodilian reptiles, the heart is a three chamber system composed of two atria (left and right) and a single ventricle. On the dorsal aspect of the right atrium is an additional structure known as the sinus venosus, which receives deoxygenated blood from the systemic circulation via four major veins (the right and left precaval veins, the postcaval vein, and the left hepatic vein) [11–13,18]. Blood then enters the right atrium through the sinoatrial aperture [11,14,17]. The left atrium receives oxygenated blood returning from the pulmonary system via the left and right pulmonary veins [11,14,18]. The single ventricle is composed of thin layers of longitudinally and spirally arranged compact myocardium surrounding a thicker layer of spongy myocardium. Two incomplete septa or muscular ridges of the spongy myocardium functionally separate the ventricle into three subchambers, the cavum venosum, cavum arteriosum, and cavum pulmonale [11–17]. An incomplete muscular ridge, the vertical septum, partially separates the cavum arteriosum (systemic flow) from the cavum venosum (pulmonary flow), which remain connected dorsally by the interventricular canal. The larger muscular ridge, the horizontal septum, lies between the cavum venosum and the cavum pulmonale [11,18,19]. During atrial systole, the atrioventricular valves partially occlude the interventricular canal to minimize intracardiac shunting, with the right atrium emptying into the cavum venosum and in late diastole into the cavum pulmonale, while the left atrium empties into the cavum arteriosum [11,12,14,18]. The atrioventricular valves prevent regurgitation back into the atria during ventricular systole and open the interventricular canal. The cavum arteriosum contracts and moves oxygenated blood through the cavum venosum. The cava venosum and pulmonale are then separated by the muscular ridge, as it moves cranially to help prevent mixing of oxygenated and deoxygenated blood. Next, the cavum venosum contracts and moves oxygenated blood to the paired left and right aortic arches. Finally, deoxygenated blood is pumped from the cavum pulmonale through the pulmonary artery. During ventricular contraction, the larger muscular ridge is brought into close apposition with the ventral wall to help create a barrier between the cava venosum and pulmonale [11,14,18]. Blood may also enter the systemic circulation from the cavum pulmonale via the left aorta [11,14]. The muscular ridges within the ventricle, sequential ventricular subchamber contractions, atrioventricular valves, systemic and pulmonary pressure differences, and other anatomical considerations all combine to minimize mixing of deoxygenated