CLINICAL REPORT

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Antemortem case of atrioventricular valve insufficiency in bearded dragon (*Pogona vitticeps*) – a case report

*Caso antemortem de insuficiência valvar atrioventricular em dragão barbudo (*Pogona vitticeps*) – relato de caso*

Ismar Lutvikadić[1]*, Dajna Preldžić[1], Alan Maksimović[1]

ABSTRACT: An atrioventricular valve insufficiency is a common form of cardiac disorder in mammals, whereas it has rarely been reported in reptiles. A two-year-old male bearded dragon (*Pogona vitticeps*) was presented with acute onset of lethargy, inappetence and general weakness, increased respiratory effort, dark skin color, and arched back. A gastrointestinal foreign body was suspected, but radiography showed coelomic fluid accumulation. Ultrasound heart examination revealed turbulent blood flow at the level of the atrioventricular valves. Electrocardiography by modified Einthoven lead system (lead configuration 1) as described for Squamata, did not show significant changes. A tentative diagnosis of congestive heart failure as a result of valvulopathy was made. Treatment consisted of parenteral furosemide and fluid administration and assisted feeding with appropriate food intended for adult bearded dragons. The patient was weekly evaluated and successfully recovered over the four months. Echocardiography and electrocardiography were repeated 12 months later. The prescribed treatment was successful with complete resolution of clinical signs, and long-term surveillance of the bearded dragon (*Pogona vitticeps*).

KEYWORDS: Valvulopathy, reptiles, cardiology, bearded dragon.

RESUMO: Uma insuficiência da válvula atrioventricular é uma forma comum de distúrbio cardíaco em mamíferos, enquanto que em répteis raramente é relatada. Um dragão barbudo macho de dois anos de idade (*Pogona vitticeps*) apresentou início agudo de letargia, inapetência e fraqueza geral, aumento do esforço respiratório, cor de pele escura e dorso arqueado. Suspeitou-se de corpo estranho gastrointestinal, mas a radiografia mostrou acúmulo de líquido celômico. O exame ultrassonográfico do coração revelou fluxo sanguíneo turbulento ao nível das válvulas atrioventriculares. O eletrocardiograma pelo sistema de derivações de Einthoven modificado (configuração de derivações 1), conforme descrito para Squamata, não mostrou alterações significativas. Foi feito um diagnóstico provisório de insuficiência cardíaca congestiva como resultado de valvulopatia. O tratamento consistiu em furosemida parenteral, administração de fluidos e alimentação assistida com alimentos apropriados destinados a dragões barbudos adultos. O paciente foi avaliado semanalmente e se recuperou com sucesso ao longo dos quatro meses. Ecocardiograma e eletrocardiograma foram repetidos 12 meses depois. O tratamento prescrito foi bem-sucedido, com resolução completa dos sinais clínicos e supervisão a longo prazo do dragão barbudo (*Pogona vitticeps*).

PALAVRAS-CHAVE: Valvulopatia, répteis, cardiologia, dragão barbudo.

INTRODUCTION

Primary degenerative endocardiosis in reptiles is still not proven but can be possible and due to the specific cardiac anatomy one-sided valvulopathy can affect the heart bilaterally (SCHILLIGER; GIRLING, 2019). Valve regurgitation or shunting, diastolic dysfunction, and diseases that affect myocardial contractility are common causes of heart failure. If the cardiovascular system is overwhelmed and the heart pump function deteriorates, venous pressure exceeds to such an extent that fluid accumulation develops. Potential congestive heart failure represents a clinical syndrome well described in domestic animals which occurs when the heart loses the ability to maintain normal venous and systemic blood pressure or when cardiac output fails to meet the body's needs. It can be a severe condition caused by congenital or acquired heart disease. This leads to a decrease in cardiac output. Heart failure can be a result of volume (valvular insufficiency, septal defect, cardiac shunts, and anemia) or pressure overload (hypertension, aortic or pulmonic stenosis). Clinical symptoms vary depending on the side that is primarily affected

[1]Department of clinical science, University of Sarajevo, Veterinary Faculty, Bosnia and Herzegovina
*Corresponding author: ismar.lutvikadic@vfs.unsa.ba
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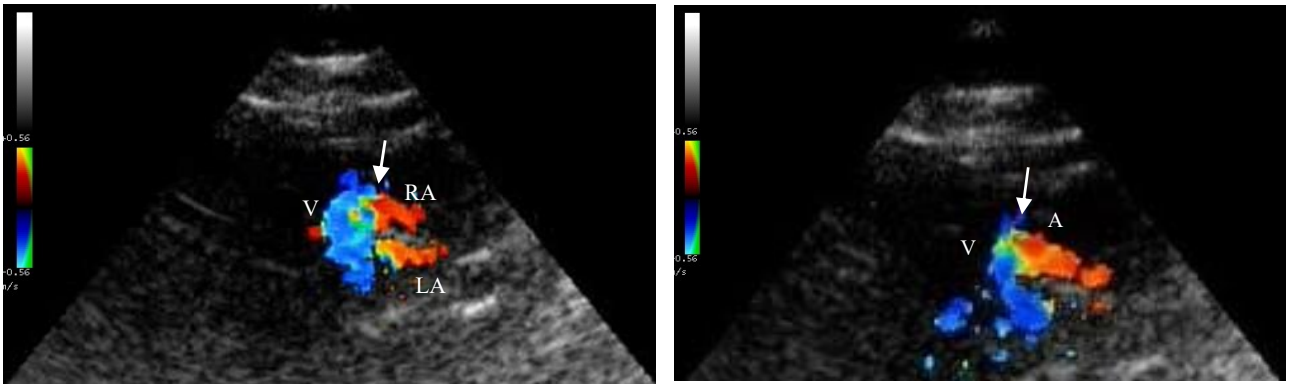
(RISHNIW; CARMEL, 1999). Radiography, echocardiography, and electrocardiography are basic diagnostic tools during heart evaluation in animals following presented clinical signs (SCHILLIGER; GIRLING, 2019; CORNELIA; KRAUTWALD-JUNGHANNS, 2022). Even though echocardiography is a very important tool in cardiac evaluation in mammals, this technique is not common in reptiles (BAGARDI et al., 2021). In reptile medicine, cardiac diseases are not well described (RISHNIW; CARMEL, 1999). It is known that cardiovascular pathology incidence in Agamidae range from 11 to 39% (REAVILL; SCHMIDT, 2009; CROUCH et al., 2021), but a diagnosis of cardiac disease in reptiles is usually obtained post-mortem (SCHILLIGER; GIRLING, 2019; BAGARDI et al., 2021). Symptoms of cardiovascular diseases in reptiles are non-specific and rarely pathognomonic. It is reasonable to suspect a cardiovascular disease in a case where pericardial, pleural edema, peripheral edema, ascites, cyanosis accompanied by general weakness, lethargy, inactivity, anorexia, change in skin color, or sudden death are present (MURRAY, 2006). In bearded dragons (*Pogona vitticeps*) echocardiography and radiography have limitations due to cranial heart placement within the pectoral girdle surrounded by bony structures (MURRAY, 2006; MATHES; WACHSMANN, 2011). Cardiac diseases in reptiles can be caused by bacteria, viruses, parasites, inadequate husbandry, or by atherosclerosis due to inappropriate diet (MURRAY, 2006; SCHILLIGER et al., 2019; CROUCH et al., 2021). Cardiac valvular insufficiency is previously described in Burmese python (*Python molurus*) and boa constrictor (*Boa constrictor*) (KIK; MITCHELL, 2005). In our case, the primary cause of the cardiac disease is unknown but the treatment of suspected condition was successful.

CASE REPORT

Two years old, male bearded dragon (*Pogona vitticeps*) weighing 300 grams was presented with signs of acute onset of lethargy, inappetence, general weakness, increased respiratory effort, dark skin color, and arched back. Gastrointestinal obstruction was primarily suspected.

According to the owner, over the past several days patient had decreased appetite, reduced activity, and was unable to hold his head up. Environmental conditions and diet met accepted requirements for captive adult bearded dragons. At the examination, increased respiratory effort with a respiratory rate of 16 breaths per minute (bpm) was observed. According to the reptile allometric scaling, the expected heart rate should be 45 beats per minute (bpm). At rest, an arched back was presented. The patient was kept in the environment at 30° C of the preferred optimum temperature before examination after which assessment of heart rate revealed tachycardia (52 bpm). The heart rate was detected by auscultation using a 3M Littmann Electronic Stethoscope where the values of auscultation and automatic display were compared and the heart murmur was not clearly audible. Automatic display values were compared with values obtained during electrocardiography, as well. The bearded dragon showed signs of dehydration where wrinkled skin and slightly cyanotic and dry mucous membranes were present and capillary refill time was longer than two seconds. The lateral radiograph revealed ventral coelomic fluid accumulation and dorsal tracheal elevation was suspected (Figure 3A). Hypothetically, potential cardiopathy and coelomic fluid accumulation are linked so an ultrasound examination started with echocardiography. An echocardiographic examination was performed by the left and right axillar approach as described by SILVERMAN et al. (2016). This approach is used to evaluate the presence of valvular insufficiency (SCHILLIGER; GIRLING, 2019). Color Doppler revealed high-velocity regurgitation at the level of atrioventricular valves visible during the systolic phase of the ventricle (Figure 1). M mode evaluation was not performed because of the inability to make a correct short-view axis of the patient's heart. The liver was also evaluated by ultrasound and echotexture described by BUCY et al. (2015) was seen with a clear gall bladder and hypoechoic portal vessel within the parenchyma (Figure 2). Electrocardiography was performed by a modified Einthoven lead system, Lead configuration 1 (Figure 4), as described for Squamata (MULLEN, 1967). According to the physiological



RA=right atrium, LA=left atrium, A=atrium

Figure 1. Color Doppler revealed turbulent blood flow at the level of AV valves during initial patient examination

ranges estimated by HUNT (2013), an ECG did not show significant changes (QRS duration was 80 mS and R wave amplitude was 0.125 mV on the paper configuration 5 mm/mV; 25 mm/s). Because of the presence of the discomfort signs fluid sampling was not performed due to the high risk of distress. A blood smear of the peripheral blood was made and the white blood cell count was in the physiological range.

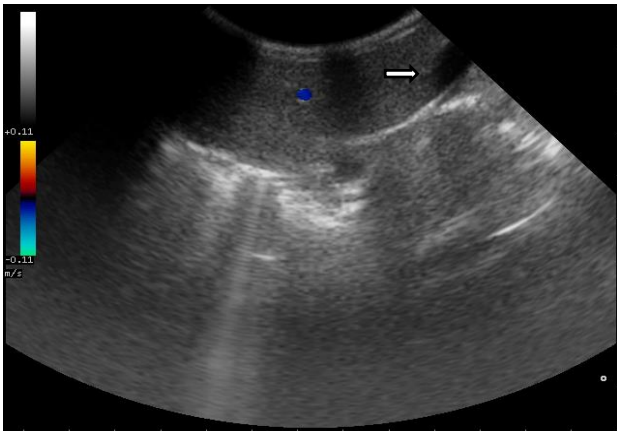


Figure 2. Ultrasound liver examination with empty gall bladder (white arrow) and blood vessel (blue spot) into liver parenchyma

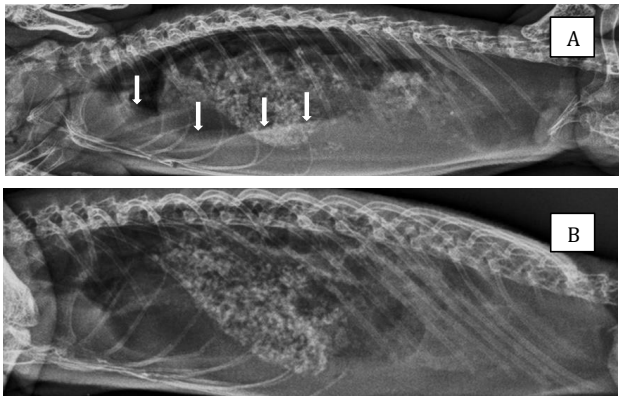


Figure 3. A – Ventral coelomic fluid accumulation (white arrows) in lateral radiography on admission. B – Less intracoelomic fluid opacity after the first seven days of treatment

Figure 4. Einthoven lead system, Lead configuration 1 as described for Squamata

Based on evaluation results, the treatment consisted of intramuscular furosemide application (5 mg/kg; bid) and assisted feeding. Due to poor blood flow and inability to insert an intravenous catheter, subcutaneous fluid therapy (10 mL/kg/day, lactated Ringer solution - LRS) was indicated. The animal has not been hospitalized during treatment. Environmental conditions during treatment met all requirements which mean environmental temperature was 30° C during the day and 18° C during the night. Furthermore, a humidity of 35% and a full spectrum of natural light were provided.

Seven days after the initial examination and beginning of treatment, the follow-up examination was performed, and the lateral radiograph revealed less intracoelomic fluid opacity (Figure 3B). Clinically meaningful improvement was observed as the patient was more active and alert. The treatment was continued with subcutaneous LRS at the same dose as it was previously prescribed, while the furosemide was reduced to 2 mg/kg subcutaneously q12h, over the next three days as was described by SIMONE-FREILICHER et al. (2015). One week later the dragon started holding his head in a regular position over a short duration, several times per day. The recorded body weight was 290 grams. The same treatment was continued with 48 hours pause every three days because blood electrolyte analysis was not possible as a part of the monitoring of the continuous furosemide treatment. This was not possible due to the inability of blood sampling as a result of poor blood flow. Seven days after, due to stagnation of clinical signs, the furosemide dose was increased to 5 mg/kg, subcutaneously twice a day, and fluid therapy was recommended in case the patient's appetite or body weight decreased. The condition of the patient significantly improved clinically during the next three months of follow-up which means the dragon was very alert and active. The checkup radiographs showed a clear coelomic cavity and electrocardiography results were still in the physiological range (QRS duration was 80 mS and R wave amplitude was 0.2 mV on the paper configuration 5 mm/mV; 25 mm/s) with a heart rate of 60 bpm following manipulation and restraining under the same environmental conditions. The final body weight was 300 grams. Four months after the initial diagnosis, treatment was discontinued due to the resolution of clinical signs. A client reported that the patient has normal behavior, appetite, and eliminations.

Echocardiography and electrocardiography were repeated 12 months later. Both methods revealed the same results as those during the first examination (Figure 5), with a heart rate of 60 bpm. All medical treatment was performed after obtaining the written consent of the owner.

DISCUSSION

There are only a few reports of cardiac diseases in reptiles and usually, the definitive diagnosis was made post-mortem (SCHILLIGER; GIRLING, 2019). Antemortem diagnosis of heart disease remains a challenge in avian medicine due to

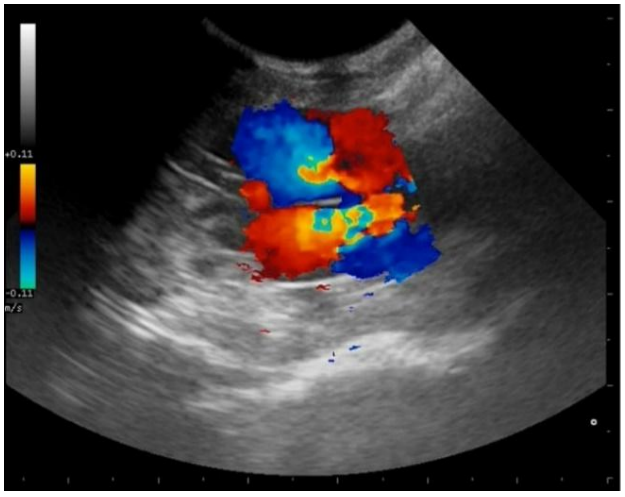


Figure 5. Turbulent blood flow at the AV valves level 12 months after initial treatment

the lack of reports, as well (CORNELIA; KRAUTWALD-JUNGHANNS, 2022). In our case, the primary cause of the cardiac disease is unknown but due to the patient's age, clinical signs, and physical findings (tachycardia and increased respiratory effort) a congenital cardiac condition, with an acute onset of clinical signs, was suspected. It should be considered that male bearded dragons are more likely affected by chronic or degenerative diseases as it is concluded by CROUCH et al. (2021). None of the diagnostic tools showed signs of cardiomegaly, probably due to the prompt reaction of the owner. Due to large turbulent blood flow, we suspected its atrioventricular valve insufficiency with consequent potential congestive heart failure. It is important to understand the univentricular anatomy of the lizard's heart which is consisted of three compartments (*cavum pulmonale*, *central cavum venosum*, and *cavum arteriosum*) (MITOVA; WITTNICH, 2021). This specificity can theoretically allow bilateral congestive heart failure development (RISHNIW; CARMEL, 1999; SCHILLIGER; GIRLING, 2019). As an important part of the clinical evaluation, heart rate estimation should always be performed. Numerous factors affect heart rate in reptiles (e.g. handling, activity, temperature) and before any procedure it should be roughly estimated by allometric formula (SCHILLIGER; GIRLING, 2019). Results of the allometric formula used without other cardiovascular parameters can overestimate the heart rate value in bearded dragons. The method used in our case revealed even higher values.

Due to a low-activity lifestyle and lower metabolic rate in these animals, it is difficult to recognize cardiovascular diseases before clinical signs become obvious. Acute treatment of congestive heart failure in mammals consists of diuretics and vasodilator administration. Chronic cases are maintained with the same medicaments, in conjunction with pimobendan, sodium nitroprusside, digoxin, and similar medications depending on heart failure type, stage, and clinical signs (ERLING; MAZZAFERRO, 2008). In general, loop diuretics are the drugs of choice in acute or chronic congestive heart failure, due to their purpose of reducing intravascular fluid volume (WALL; RUSCH, 1992). Using loop diuretics patient usually reduces body weight by 5-7% (MAZZAFERRO, 2005). Furosemide is the most frequent loop diuretic in veterinary and human medicine, which inhibits sodium and chloride reabsorption at the level of the ascending part of the loop of Henle. Due to its unknown effect, furosemide was not frequently used in reptile medicine because they do not possess loops of Henle in the kidneys (MITCHELL, 2009). Anecdotally, it is considered they affect proximal tubules in the kidney to achieve diuresis in these animals. Furosemide in reptiles with congestive heart failure is recommended in dosages from 1-15 mg/kg in different frequency applications. Depending on the case, treatment results were inconsistent (RISHNIW; CARMEL, 1999; REDROBE; SCUDAMORE, 2000; PARKINSON; MANS, 2018). In addition to the mammals' congestive heart failure treatment, pimobendan is frequently used. Pimobendan is a benzimidazole-pyridazinone derivative and it's classified as an inodilator due to its vasodilatory and positive inotropic effects in mammals (ERLING; MAZZAFERRO, 2008). In exotic medicine, the usage of pimobendan is anecdotal and literature information in reptile medicine is not available (MEREDITH, 2015) so we did not include this drug in the case. This was also confirmed by SIMONE-FREILICHER et al. (2015) on 6 years old bearded dragon who made a tentative diagnosis of congestive heart failure. In that case, only echocardiography was made with no specification of color Doppler or ECG diagnostics, and the blood panel was changed so different possible causes of the severe lymphocytosis and cardiac disease were speculated. In our case, the blood smear show no changes but detailed blood analysis was not possible. The color Doppler revealed turbulent flow which strongly suggests atrioventricular insufficiency as the main cause of the cardiac disease.

Because furosemide administration leads to increased diuresis and consequently dehydration of the patient it is very important to choose and apply an appropriate electrolyte solution. Diuretic-induced dehydration leads to chronic kidney disease with severe complications and possible lethal outcomes (OLIVERI et al., 2022). There are several recommendations of fluid therapy in reptile medicine using isotonic crystalloids (LRS) or nonlactated (reptile Ringer solution - RRS) fluid made of a 1:1 mixture of LRS and 5% dextrose (MADER; RUDLOFF, 2006; PARKINSON; MANS, 2020). In our case, LRS was used due to fewer changes in glucose level, plasma osmolality, sodium, and phosphorus concentration compared to RRS (PARKINSON; MANS, 2020). Due to adequate liver parenchyma image during ultrasound examination the hepatic lipidosis, as a potential cause of the disease, was excluded.

CONCLUSION

Atrioventricular valve insufficiency was detected in the bearded dragon using color Doppler echocardiography. Twelve months after the initial diagnosis the patient still has normal behavior, appetite, and eliminations. To the best of our knowledge, this is the first antemortem atrioventricular valve insufficiency diagnosis with successful treatment, complete resolution of clinical signs, and long-term surveillance in the bearded dragon. Further clinical reports would be extremely valuable.

Conflict of interests

The authors declare that they have no conflict of interest with respect to the research, authorship, and/or publications of this article.

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