Acta Scientiae Veterinariae, 2025. 53(Suppl 1): 1073.

CASE REPORT
Pub. 1073

ISSN 1679-9216

Atrial Flutter in a Giant Anteater (*Myrmecophaga tridactyla*): Electrocardiographic Diagnosis and Echocardiographic Evaluation

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ABSTRACT

***Background*:** Cardiac evaluations in wild animals are essential for assessing health status prior to rehabilitation and release. The giant anteater (*Myrmecophaga tridactyla*), classified as vulnerable by the IUCN, frequently requires rescue and health assessments due to increasing threats from habitat destruction. Cardiovascular assessments such as electrocardiography (ECG) and echocardiography (ECHO) are critical but remain scarcely studied in this species. This report aimed to describe the 1st diagnosis of atrial flutter in a free-ranging giant anteater using ECG, supported by an echocardiographic evaluation to investigate possible structural alterations.

***Case*:** A free-ranging female giant anteater was rescued in Paraná, Brazil, and chemically restrained with ketamine, midazolam, and morphine. Physical examination showed ectoparasites, superficial lesions, and signs of estrus. The animal weighed 40 kg and had stable physiological parameters. The animal underwent electrocardiogram (ECG) monitoring using an INcardio X® device. ECG findings revealed paroxysmal atrial flutter, characterized by regular atrial activity without distinct P waves. The ECG showed a mean heart rate of 54 bpm, a QRS duration of 64 ms, a QTc of 332 ms, and an ST segment depression of -0.3 mV. Heart rate variability was analyzed using time-domain measures and nonlinear methods, and indicated an SDNN of 68.7 ms, RMSSD of 32.9 ms, CSI of 4.05, and CVI of 1.03. These data suggested transient autonomic alterations likely related to handling stress and sedation. Echocardiogram (ECHO) was performed using the SonoSite M-TURBO® ultrasound system equipped with a sector transducer. ECHO showed no structural cardiac abnormalities. Measurements such as LVIDs (1.47 cm), IVSs (1.46 cm), LVPWs (1.62 cm), and LA/AO ratio (1.06) were within or slightly above reference values, possibly due to the animal's adult age and natural cardiac growth. The ejection fraction was 72%, and fractional shortening was 40.1%, indicating preserved systolic function.

***Discussion*:** This was the 1st electrocardiographic record of atrial flutter in a giant anteater. The ECG pattern was consistent with atypical type II flutter, with positive F waves in inferior leads, suggesting a clockwise reentrant circuit, with activation of the interatrial septum occurring from superior to inferior. Although atrial flutter in other species is often linked to structural heart disease or atrial remodeling, ECHO findings in this case ruled out significant cardiac anomalies. Minor deviations from reference ranges were attributed to age-related growth, as the animal was older than individuals in previous studies. The data suggest that atrial flutter was likely stress-induced or related to the sedative protocol. These findings highlight the importance of cardiovascular monitoring during wildlife rescue operations and the potential role of sedative agents in arrhythmogenesis. The transient nature of the arrhythmia and absence of structural abnormalities supported the animal's release. Further research is crucial to refine sedation protocols and better understand the cardiovascular physiology of this vulnerable species. This case emphasizes the value of combining ECG and ECHO for comprehensive cardiac assessment in wildlife and contributes original reference data for future health evaluations of giant anteaters.

Keywords: electrocardiography, echocardiography, wildlife conservation, sedative protocols, arrhythmogenesis.

DOI: 10.22456/1679-9216.147827

Received: 27 July 2025 Accepted: 9 December 2025 Published: 28 December 2025

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INTRODUCTION

The giant anteater (*Myrmecophaga tridactyla*) is a mammal native to South America, widely distributed across various biomes in Brazil, including the Cerrado, Pantanal, Atlantic Forest, Amazon, and parts of the Caatinga [9]. This species is distinguished by its unique physical characteristics, such as an elongated snout, extensible tongue, dense fur, and large bushy tail. Reaching lengths of up to 2 m, the giant anteater plays a crucial ecological role by regulating insect populations, particularly ants and termites, within its habitat [4]

Despite its ecological significance, the giant anteater is currently listed as "Vulnerable" by the International Union for Conservation of Nature (IUCN), largely due to habitat loss caused by agricultural expansion, deforestation, and wildfires. These anthropogenic pressures have led to the fragmentation of its natural habitats, confining the species to increasingly smaller and less secure areas [8]

Due to these pressures, rescue efforts for injured or stranded anteaters are critical, especially in preparation for their reintroduction into the wild to ensure the survival of this species [8]. As part of their health assessment, it is essential to evaluate cardiovascular health, using tools like electrocardiography (ECG) and echocardiography (ECHO), to detect any abnormalities that could impair the animal's survival in the wild. However, there is limited research on the echocardiographic characteristics of the giant anteater [1,13], and no studies to date have investigated the species' electrocardiographic profiles. This study aims to report, for the 1st time, the diagnosis of atrial flutter in a giant anteater through ECG, followed by an echocardiographic evaluation to assess for any underlying structural heart issues.

CASE

A free-ranging giant anteater (*Myrmecophaga tridactyla*) was rescued by the Fire Department and Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) in the municipality of Capanema, Paraná, Brazil. To ensure the safe handling of the animal, chemical restraint was employed using intramuscular administration of ketamine[1] [5 mg/kg], midazolam [0.5 mg/kg][2] and morphine [0.2 mg/kg][3]. During the physical examination, the animal was found to have ectoparasites, including ticks and fleas, as well as superficial lesions on the forelimb region, which were cleaned thoroughly. Additionally, signs of estrus were observed, evidenced by vulvar swelling and the presence of secretions. The animal displayed an appropriate body condition score, weighing 40 kg. Physiological parameters measured included a rectal temperature of 32.7°C, a heart rate of 44 beats per minute, a respiratory rate of 12 movements per minute, a capillary refill time of 1 s, and an estimated hydration status exceeding 95%.

For electrocardiographic evaluation, the INcardio X®[4] device with a 6-lead electrode system was used to obtain wave amplitudes, mean electrical axes, and sympathovagal balance over a 7-minute recording period. The patient was positioned in right lateral recumbency, and alligator-clip electrodes were placed on the cutaneous folds of the thoracic and pelvic limbs bilaterally. After the examination, the results were analyzed using the INcardioDuo®[4] software. Heart rate variability (HRV) was analyzed using time-domain measures and nonlinear methods, following the approach described by Shaffer and Ginsberg [11].

The electrocardiographic evaluation revealed paroxysmal atrial flutter (Figure 1A), characterized by rapid and regular atrial contractions without distinct P waves. Analysis of the ECG data showed a minimum heart rate of 48 beats per minute, a mean of 54 beats per minute, and a maximum of 68 beats per minute. The P wave, when visible in sinus rhythm, had a duration of 58 milliseconds and an amplitude of 0.04 millivolts, with an axis calculated at 20.2°. The QRS complex had a duration of 64 milliseconds, with amplitudes of 2.06 millivolts for the R wave, -0.08 millivolts for the Q wave, and -0.3 millivolts for the S wave. The QRS axis was measured at 78.33°. The T wave had a duration of 250 milliseconds and an amplitude of 0.36 millivolts. Other intervals measured included a PR interval of 94 milliseconds, a QT interval of 364 milliseconds, and a corrected QT interval (QTc) of 332 milliseconds. The ST segment demonstrated a displacement of -0.3 millivolts.

Heart rate variability analysis provided additional insights. Temporal parameters showed a standard deviation of normal-to-normal intervals (SDNN) of 68.7 milliseconds and a root mean square of successive differences (RMSSD) of 32.9 milliseconds. Nonlinear indices indicated a composite sympathetic index (CSI) of 4.05 and a composite vagal index (CVI) of 1.03. The histograms (Figure 1B) obtained from the heart

Figure 1. A- Electrocardiographic recording of an adult female giant anteater (*Myrmecophaga tridactyla*) rescued in the state of Paraná, Brazil. The electrocardiographic exam, performed in lead DII at a speed of 25 mm/s and with an amplitude of 5 mm/mV, revealed the presence of F-waves, indicative of atrial flutter. B- The histograms obtained from the heart rate variability analysis, demonstrating the distribution of heart rates over the monitoring period, highlighting fluctuations in the cardiac rhythm during the evaluation.

rate variability analysis demonstrated the distribution of heart rates over the monitoring period, highlighting fluctuations in the cardiac rhythm during the evaluation. These findings, combined with the observation of atrial flutter, suggested transient cardiac alterations potentially associated with the stress of handling and chemical sedation.

To investigate whether the atrial flutter could be linked to any structural heart abnormalities, an echocardiogram (Figure 2) was performed using the SonoSite M-TURBO®[5] ultrasound system[5] equipped with a sector transducer. The evaluation adhered to the guidelines established by the Echocardiography Committee of the American College of Veterinary Internal Medicine.

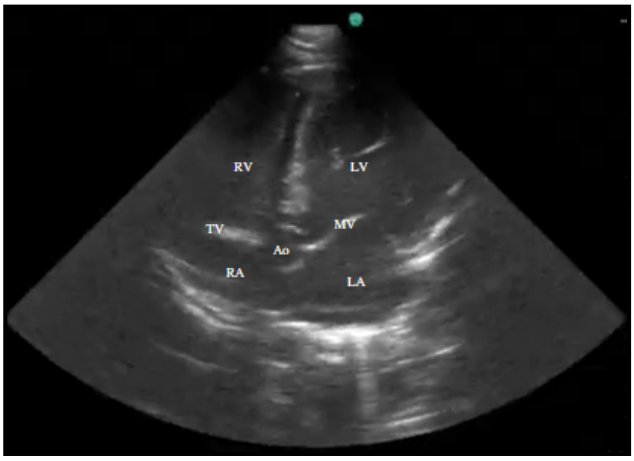

Figure 2. Echocardiographic assessment in the 5-chamber apical view of an adult female giant anteater (*Myrmecophaga tridactyla*) rescued in the state of Paraná, Brazil. [RA= Right atrium; RV= right ventricle; LA= left atrium; LV= Left ventricle; Ao= aorta; MV= Mitral valve; TV= Tricuspid valve].

The examination revealed no structural abnormalities in the cardiac chambers or valves. The diameter of the left ventricle at the end of systole (LVIDs) was 1.47 cm, with a thickness of the interventricular septum at the end of systole (IVSs) of 1.46 cm and of the free wall of the left ventricle in systole (LVPWs) of 1.62 cm. In diastole, the interventricular septum (IVSd) measured 1.57 cm, the left ventricle in diastole (LVIDd) was 2.3 cm, and the free wall of the left ventricle in diastole (LVPWd) was 1.23 cm. The diameter of the aorta (AO) was 2.42 cm, while the left atrium (LA) measured 2.56 cm, with a LA/AO ratio of 1.06. The ejection fraction (EF) was 72%, and the fractional shortening (FS) reached 40.1%. The maximum velocity at the pulmonary valve was 62.6 cm/s, while the peak pressure gradient (PPG) was 1.57 mmHg, and the velocity time integral (VTI) was 8.64 cm. The analysis of the mitral valve revealed an E/A ratio of 1.82. The tricuspid annular plane systolic excursion (TAPSE) was 1.34 cm. These values indicate preserved cardiac function, with no significant abnormalities observed.

DISCUSSION

This case presents atrial flutter type II, characterized by a clockwise conduction circuit, with activation of the interatrial septum occurring from superior to inferior. The electrocardiographic features include F waves with positive deflections in the inferior leads (II, III, and aVF), indicative of superior-to-inferior activation, contrasting with the counterclockwise (anti-clockwise) direction seen in typical atrial flutter.

The positive deflections in the inferior leads suggest a clockwise direction of conduction, consistent with an anatomical or functional reentrant circuit in the atria [6].

According to Santilli *et al.* [10], atrial flutter can be associated with structural abnormalities in the heart, such as atrial remodeling. Atrial remodeling is a pathological process that can occur due to various conditions, including chronic hypertension, heart failure, valvular diseases, and atrial fibrillation. This remodeling leads to changes in the architecture and electrophysiological properties of the atrium, creating an environment conducive to the formation of reentrant circuits, such as those seen in atrial flutter. These structural changes can involve atrial fibrosis, atrial dilation, and other types of tissue alterations that contribute to electrical dysfunction and the maintenance of atrial flutter. These structural and electrophysiological mechanisms may be associated with both typical and atypical atrial flutter, depending on the characteristics of the conduction circuit and the presence of areas of abnormal conduction in the atrium.

The echocardiographic examination revealed no structural abnormalities in the cardiac valves. Although some of the values obtained in the evaluation slightly deviated from the reference values, it is believed that this discrepancy may be attributed to the age of the animals. In a previous study [1], the animals used to establish reference values were females less than 2-years-old and males less than 3-years-old, classified as juveniles [3]. In contrast, the female evaluated in the present work was confirmed to be 3-years-old, as she exhibited physical signs of estrus identified through physical examination and abdominal ultrasound, consistent with the information in the literature [3], which indicates that the average age of 1st reproduction for females in the wild is around 3 years.

Therefore, the age difference between the animals in the 2 studies may explain the observed variations in the results. Furthermore, the values obtained in our study, which were slightly higher than the reference values, particularly regarding the size of the cardiac chambers, ventricle, and septum, could reflect the natural growth of the animal. As animals increase in size, their cardiac dimensions typically expand proportionally [12]. Notably, the left atrium to aorta ratio (LA/AO) and the E/A ratio were within expected reference ranges, suggesting preserved cardiac function.

While atrial flutter can arise from structural abnormalities such as atrial remodeling or fibrosis [7], the absence of these abnormalities in the echocardiogram suggests that the observed atrial flutter in this giant anteater may be more likely associated with functional factors, such as stress, sedation, or pharmacological agents used during restraint. The combination of ketamine and midazolam employed in this case has not been directly linked to atrial flutter in veterinary literature.

However, several studies have shown that certain drugs, including opioids like morphine, can predispose animals to atrial flutter due to their effects on the autonomic nervous system and vagal tone. Morphine, for example, has been shown to reduce atrioventricular conduction velocity and increase vagal tone, creating conditions favorable for atrial flutter or fibrillation [2].

Heart rate variability (HRV) analysis provided additional insights into the animal's autonomic response. Temporal indices, including SDNN (68.7 ms) and RMSSD (32.9 ms), along with nonlinear indices such as CSI (4.05) and CVI (1.03), indicated a predominance of sympathetic activity. This autonomic imbalance may reflect the physiological stress of handling, as well as the pharmacodynamic effects of ketamine, which is known to increase sympathetic tone [5]. The transient nature of the atrial flutter observed here aligns with findings in other species, where arrhythmias induced by sedation or stress resolve spontaneously following the elimination of pharmacological agents. The absence of pericardial effusion, myocardial hypertrophy, or valvular dysfunction in this individual is consistent with the reported low prevalence of primary cardiac diseases in giant anteaters [1].

The combined electrocardiographic and echocardiographic evaluations conducted in this study provide valuable insights into the cardiovascular health of the giant anteater. The transient atrial flutter observed was likely influenced by the stress of handling and the effects of sedation, emphasizing the importance of monitoring cardiac function in wildlife rescue settings. Additionally, the echocardiographic findings confirmed the absence of structural abnormalities, supporting the suitability of this individual for release. These results contribute to the growing body of knowledge on the species and highlight the need for continued research on the cardiovascular physiology of giant anteaters.

The findings of this study underscore the importance of cardiovascular evaluation in rescue and reintroduction programs for wildlife. Atrial flutter, while transient in this case, highlights the need for careful monitoring during sedation and recovery to prevent potential complications. Although pharmacological agents like ketamine and midazolam are commonly used due to their safety profiles, their effects on autonomic balance warrant further investigation in species such as the giant anteater. Future studies should explore alternative sedation protocols to minimize the risk of arrhythmias and ensure optimal cardiovascular stability.

MANUFACTURERS

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Acknowledgements. The present work was carried out with the support of the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES).

Declaration of interest. The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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