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CASE REPORT
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Oculocardiac Reflex and Autonomic Modulation in a Broad-Snouted Caiman (*Caiman latirostris*)

Ana Letícia Rodrigues Marques[1], Marina Marangoni[1], Vitor Eduardo Mamguê[1], Mel Takazono Lemes[1], Oscar Martínez[2], Paulo Henrique Braz[1] & Tatiana Champion[1]

ABSTRACT

***Background*:** The oculocardiac reflex (OCR) is a neurophysiological response mediated by the vagus nerve, triggering changes in heart rate and rhythm in response to pressure applied to the ocular globe. While well-documented in humans and other mammals, the OCR remains less explored in reptiles, particularly crocodilians. Given the rising interaction between wildlife and urban settings, understanding OCR in these species has become essential due to potential implications in veterinary and wildlife medicine. This case report aimed to investigate the OCR in a broad-snouted caiman rescued from an urban environment, providing insights into its autonomic responses under ocular compression.

***Case*:** A juvenile broad-snouted caiman, approximately 45 cm in length and weighing 0.8 kg, was rescued from an urban household in Capanema, Paraná, Brazil. The animal, found in a dehydrated and lethargic state far from its natural habitat, was transported to the Wildlife Animal Service at the veterinary hospital of the Federal University of Fronteira Sul (UFFS), Realeza campus, for evaluation and possible release. The animal underwent electrocardiogram (ECG) monitoring using an INcardio X® device (INpulse, Florianópolis, SC, BR) to assess changes in heart rate and rhythm during ocular pressure, simulating vagal stimulation. Surface cup electrodes coated with conducting gel were placed on the animal's cranial and caudal limbs for ECG readings. Application of ocular pressure induced a notable OCR response, evidenced by a 47% decrease in heart rate, dropping from 34 bpm to 16 bpm, along with changes in heart rate variability (HRV) parameters and a 2nd-degree atrioventricular block. Three min after the release of ocular pressure, the heart rate returned to 29 bpm, with HRV values returning to baseline, indicating a recovery of autonomic balance.

***Discussion*:** Manual restraint in crocodilians often involves ocular pressure to facilitate temporary immobilization through vagal activation. However, the OCR poses substantial cardiovascular risks, as highlighted by this case. During OCR activation, HRV metrics such as Standard Deviation of NN intervals (SDNN) and Root Mean Square of Successive Differences (RMSSD) rose, reflecting increased heart rate variability likely due to heightened parasympathetic activity. Additionally, increases in the mean NN interval and the Cardiac Vagal Index (CVI) pointed to enhanced vagal modulation, while a drop in the Cardiac Sympathetic Index (CSI) indicated diminished sympathetic response. Changes in DFA parameters with increased α-1 and decreased α-2 values reflected short-term variability and reduced long-term complexity, respectively. These shifts underscored a significant autonomic imbalance dominated by parasympathetic tone. The atrioventricular block and multiple sinoatrial node depolarizations observed during the OCR response align with known reptilian cardiac responses to parasympathetic dominance. Similar findings have been reported in canine studies during OCR, suggesting that vagal modulation of HRV may share patterns across taxa. The results of this report underline the necessity of safety precaution for handling of crocodilians during ocular manipulation, as failure to recognize OCR could result in severe bradycardia, arrhythmias, or even cardiac arrest. Future studies should expand on the physiological implications of OCR in crocodilians, as insights from these investigations will be critical for veterinary practices involving these animals. This report provides pioneering data on HRV and OCR in a caiman, offering valuable perspectives for improving welfare and safety protocols in wildlife and veterinary care.

Keywords: bradycardia, crocodilian, heart rate, heart rate variability, vago-vagal reflex.

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[1]Universidade Federal da Fronteira Sul (UFFS), Realeza, PR, Brazil. [2]CardioVet El Salvador, San Salvador, El Salvador. CORRESPONDENCE: A.L.R. Marques [marquesrana@gmail.com] & M. Marangoni [marinamarangoni7@gmail.com]. Av. Edmundo Gaievski n.1000. Rodovia BR 182 - Km 466. Rural Area. CP 253. CEP 85770-000 Realeza, PR, Brazil.

INTRODUCTION

The oculocardiac reflex (OCR) is a neurophysiological response mediated by the vagus nerve, which lead to changes in heart rate and rhythm when pressure is applied to the ocular bulb or its surrounding structures [10,16]. This reflex is well-documented in humans and other mammals, particularly during ophthalmic surgeries, since it can lead to bradycardia, hypotension, or even cardiac arrest [11,14]. Despite its clinical importance, the OCR is less studied in reptiles, particularly crocodilians [4]. Understanding the OCR in these species is crucial, given the increasing interactions between wildlife and urban environments, which often necessitate medical intervention [1].

The broad-snouted caiman (*Caiman latirostris*) is native to freshwater habitats in South America, including wetlands, rivers, and lakes [17]. The presence of a caiman in an urban setting far from its natural habitat raises significant ecological and health concerns [1]. This case report details the observation of the OCR in a broad-snouted caiman rescued from an urban household in Capanema, Paraná, and discusses the implications for wildlife medicine and veterinary practices.

CASE

A juvenile broad-snouted caiman was rescued by the Chico Mendes Institute for Biodiversity Conservation (ICMBio) from an urban household in Paraná state, Brazil. The caiman, measuring approximately 45 cm in length and weighing 0,8 kg, was found in a dehydrated and lethargic state, far from its natural aquatic habitat. The animal was immediately transported to the Wildlife Animal Service at the veterinary hospital of the Federal University of Fronteira Sul (UFFS) for a comprehensive health evaluation and potential release back into the wild.

The caiman was monitored using an electrocardiogram (ECG) to observe changes in heart rate and rhythm in response to vagal stimulation induced by physical restraint through ocular pressure. The ECG were recorded using surface cup electrodes, coated with a layer of conducting gel and placed on the cranial and caudal members of the animal. The ECG recorded using a INcardio X®1 data acquisition system. Notably, the application of pressure to both eyes elicited a pronounced OCR, characterized by a significant decrease in heart rate from 34 beats per minute (bpm) to 16 bpm, a 47% reduction (Figure 1). The values of heart rate variability (HRV) shifted, with disbalance of autonomic activity (Table 1). Also a 2nd-degree atrioventricular block was identified with multiple depolarizations in the sinoatrial node region (Figure 2). After 3 min, following the removal of ocular compression, the heart rate recovered to 29 bpm. Additionally, the HRV parameters returned to baseline levels, indicating a recovery of autonomic function.

Table 1. Heart Rate Variability (HRV) parameters measured at baseline, during observation of the oculocardiac reflex, and post-reflex in a broad-snouted caiman (*Caiman latirostris*).

HRV Parameter	Values	
	Baseline	During OCR
SDNN (ms)	92.065	496.106
Mean NN (ms)	1,734.277	3,655.63
RMSSD (ms)	26.561	348.532
ApEn	0.112	0.742
CVI	3.343	5.193
CSI	6.567	2.587
α -1 (DFA)	0.955	1.397
α -2 (DFA)	2.025	-1.000
Sympathetic (%)	66.27%	33.25%
Parasympathetic (%)	33.73%	66.75%

SDNN = Standard Deviation of NN intervals; Mean NN = Mean of NN intervals; RMSSD = Root Mean Square of Successive Differences; ApEn = Approximate Entropy; CVI = Cardiac Vagal Index; CSI = Cardiac Sympathetic Index; α-1 (DFA) = Short-term Detrended Fluctuation Analysis; α-2 (DFA) = Long-term Detrended Fluctuation Analysis.

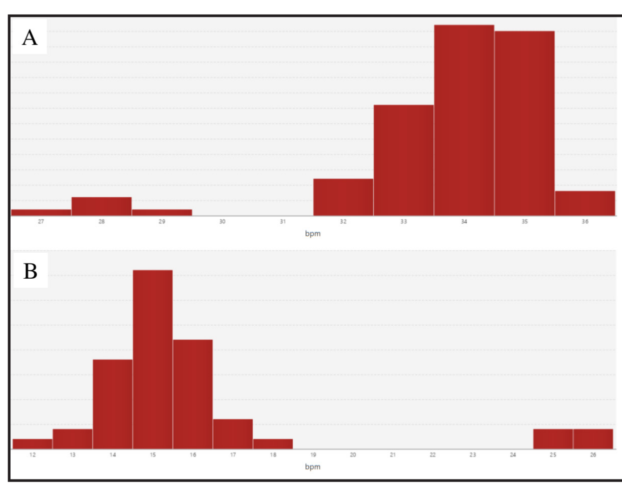

Figure 1. Histograms demonstrating heart rate changes at baseline (A) and during the observation of the oculocardiac reflex (B) in a broad-snouted caiman (*Caiman latirostris*).

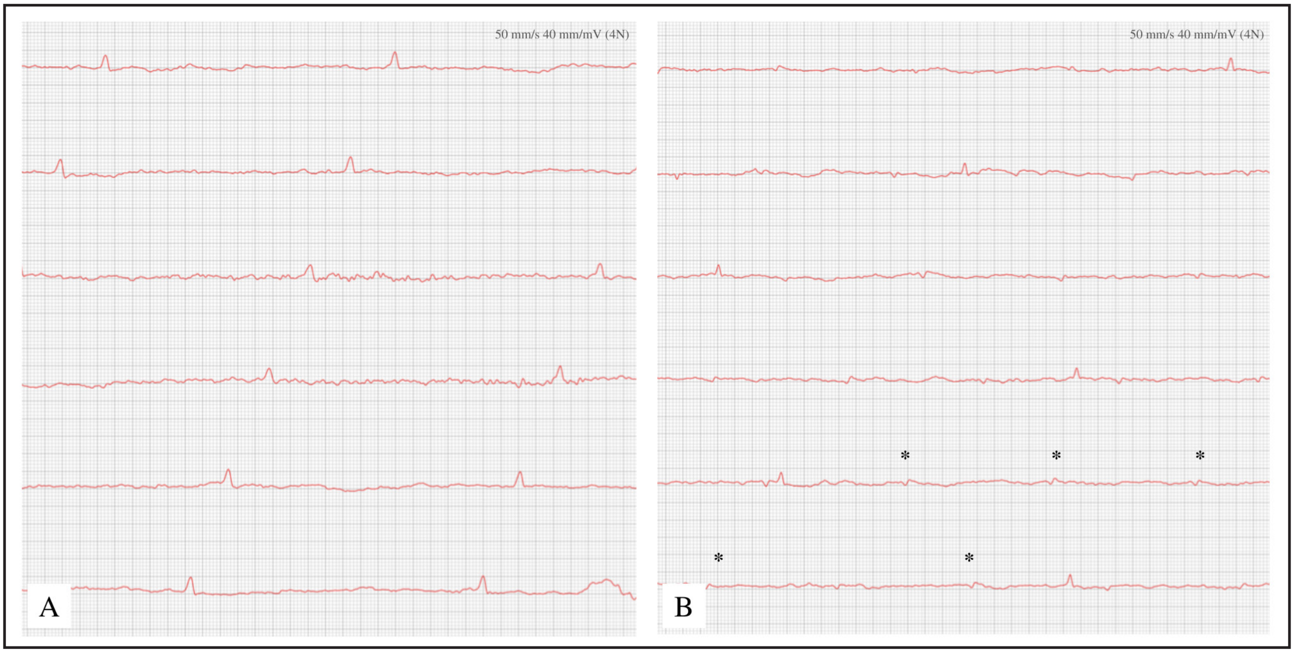

Figure 2. Electrocardiograms recorded at baseline (A) and during the observation of the oculocardiac reflex (B) in a broad-snouted caiman (*Caiman latirostris*). The OCR significantly decreased the heart rate and induced a 2nd-degree atrioventricular block (*).

DISCUSSION

Manual restraint in reptiles, including crocodilians, often involves applying pressure to the eyes to induce temporary immobilization via vagal stimulation [6]. That many lizards, such as Chinese water dragons and young iguanas, can be temporarily immobilized by applying digital pressure to both eyes simultaneously [6]. However, the potential risks of this method, particularly the induction of severe cardiovascular responses via the OCR, must be carefully considered.

The OCR is a neurophysiological response involving afferent and efferent pathways. The afferent pathway begins with the stimulation of the ciliary nerves, which transmit impulses to the ciliary ganglion [14]. Impulses follow via the ophthalmic branch of the trigeminal nerve (cranial nerve V) to its principal sensory nucleus near the 4th ventricle in the brainstem [16]. The efferent pathway involves the vagus nerve (cranial nerve X), which carries the response signal to the heart, resulting in bradycardia or other cardiac arrhythmias [3,15].

This reflex is commonly triggered during ophthalmic surgeries in mammals due to manipulation of the ocular bulbs, necessitating the cessation of manipulation to prevent severe cardiac arrhythmias. The literature emphasizes the importance of recognizing and managing the OCR during ophthalmic surgeries to prevent adverse cardiac events [15].

The OCR's presence and significance in reptiles, particularly crocodilians, have been under-researched. A study with *Pogona vitticeps* reported that 62% of tested specimens exhibited the OCR, suggesting reptiles' susceptibility to this reflex. The authors noted significant heart rate reductions during OCR tests but observed increased stress and non-compliance with prolonged ocular pressure [10].

Although the literature on the physiological parameters of broad-snouted caimans is scarce, an autonomic study has demonstrated that their heart rate can range between 28 and 39 bpm [8]. In the present study, a heart rate decrease below this expected range was observed (16 bpm), suggesting that physical restraint through ocular compression may pose risks to the health of the patient. This reflex can lead to severe bradycardia, hypotension, or even cardiac arrest if not promptly recognized and managed [16].

Heart rate variability (HRV) is a parameter that provides insights into the autonomic nervous system's regulation of the heart [2,9,13]. In this case, we observed a significant change in values of HRV during the OCR (Table 1).

The Standard Deviation of NN intervals (SDNN) and Root Mean Square of Successive Differences (RMSSD) increased reflecting an elevation in overall heart rate variability, possibly due to parasympathetic activity in response to OCR. The mean NN interval and Cardiac Vagal Index (CVI) increased indicating enhanced vagal modulation of heart rate, while the Cardiac Sympathetic Index (CSI) decreased reflecting a reduction in sympathetic activity.

The DFA parameters also changed, with α -1 increasing indicating greater correlation and variability in short-term heart rate dynamics, and α -2 dropping indicating a significant shift in long-term heart rate dynamics and reduced complexity during the OCR. Therefore, the balance of autonomic activity shifted, with predominance parasympathetic activity [9,13].

Although no studies have investigated the correlation between HRV and the OCR in reptiles, our observations are consistent with findings described in canine models A study evaluated HRV parameters during the oculocardiac reflex in healthy dogs and demonstrated a significant increase in vasovagal tone following ocular compression [2].

Additionally, during the evaluation, a 2nd-degree atrioventricular block was also identified. Multiple depolarizations were observed in the sinoatrial node region. This characteristic is typically observed in reptiles with increased parasympathetic stimulation [5,12]. The occurrence of atrioventricular block can progress to severe arrhythmias and may lead to complete cardiac arrest if not managed [7].

These HRV findings underscore the significant autonomic disbalance occurring during the OCR, highlighting the reflex's potential to induce marked cardiovascular changes [13]. Recognizing these changes is crucial for veterinarians to manage the risks associated with ocular manipulation in reptiles. This report represents the 1st documented analysis of HRV and OCR relation in a caiman, providing novel insights into the autonomic responses of crocodilians to ocular pressure.

The observation of a pronounced OCR in a broad-snouted caiman highlights the need for increased awareness and understanding of this reflex in reptiles, particularly crocodilians. Veterinary practitioners should consider the potential risks associated with ocular pressure during examinations and procedures and employ appropriate techniques to mitigate adverse cardiovascular responses. Further research is essential to elucidate the OCR's mechanisms and clinical implications in crocodilians, ultimately enhancing the standards of care in wildlife medicine.

MANUFACTURER

[1]INpulse Animal Health. Florianópolis, SC, Brazil.

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