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Electrocardiography of Snake- A Mini Review

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Introduction

Reptile cardiology is an underdeveloped specialty of reptile medicine. During the 19th century, a significant amount of research was done to elucidate the cardiac physiology of reptiles. Although a great deal is known regarding the function of the reptile heart, its application to clinical veterinary medicine has been limited.

Topographical Anatomy of Heart

In snakes, the heart is found along the midline axis and its longitudinal position varies with species. Thus, in marine and freshwater snakes, it is positioned near the middle of the body (25 to 45% of total body length). In non-tree dwelling snakes, it is found at about 25% of total body length, and about 15% (i.e. more cranially) in arboreal species. These variations in heart positions can be understood when considering the different physical forces to which the heart is subjected to in snakes occupying different biotypes. A cranially positioned heart reduces the hydrostatic pressure above the heart and so stabilizes variations in cephalic blood pressure.

Some studies have shown that those species of snakes that spend time raising their heads (arboreal and other climbing snakes) possess relatively shorter vasculature between the heart and head than do terrestrial species. The reverse is true in aquatic species, which experience less effects of gravity in water. Because of the lack of diaphragm, the snake's heart is mobile within the coelomic cavity, which probably facilitates the movement of large whole prey in the esophagus. In the coelom, the heart is found adjacent to the caudal tracheal rings, caudal to the thyroid, cranial to the bronchial bifurcation, close to the cranial pole of the lung(s) and slightly cranial to the liver. Externally, the position of the heart is indicated by percutaneous visualization of the ventral precordial tap by placing the animal in dorsal recumbency and stretching it.

Physiology

Conduction and heart rate

Unlike mammals, reptiles do not have a specialized cardiac conduction system such as pacemaker nodes and Purkinje fibers. Instead, the contractions are initiated by cardiac muscle fibers in the sinus venosus of the right atrium, which spread in sequential coordination, first to the left and caudally. The ventricle is depolarized starting at its base and then proceeding to the left. Repolarization starts from the base and spreads equally to the right and left towards the apex. The heart receives innervations from both parasympathetic and sympathetic fibers. The parasympathetic fibers run in the vagus nerve and provide cholinergic (inhibitory) control. The less well-developed sympathetic fibers cause positive chronotropism via adrenergic innervation. Heart rates (HR) are in general slower in reptiles compared to mammals or birds.

Heart rate is dependent on numerous factors:

1. Body temperature (increasing during basking and lowering during cooling, myocardial efficiency being optimum when the reptile is within its preferred optimal temperature zone)

2. Body size (heart rate is inversely proportional to the animal's size)

3. Activity (heart rate is proportional to metabolic level)

4. Respiratory rate bradycardia is observed during apnea as pulmonary resistance increases and blood flow to the lungs decreases)

5. Hypovolemia (reptiles that experience blood loss as a result of surgery or trauma can become tachycardic to ensure that the tissues remain oxygenated)

6. Digestion, gravidity and sensory (stimulations such as handling, postural and gravitational stress.

7. Heart rate also plays a significant role in thermoregulation: it increases when the animal lies in the sun, and vice versa. Thus, tachycardia and peripheral vasodilatation increase heat loss from cutaneous vascularization when ambient temperature increases, whereas bradycardia and peripheral vasoconstriction decrease heat loss when ambient temperature drops. This mechanism, which often anticipates internal temperature variations, is regulated by cutaneous thermoreceptor.

Electrocardiography

Electrocardiography (ECG) can greatly enhance the diagnosis of cardiac disease in reptiles and is also beneficial for monitoring patients under anesthesia. The main challenge associated with the use of ECG in reptiles are the low electric amplitudes (usually <1.0mv) which do not always provide readings of diagnostic quality. The electrodes can be self-adhering skin electrodes (designed for human use), stainless steel hypodermic needles, stainless steel suture material or alligator clips. Placement of the electrodes varies according to species but is usually inspired from the traditional four limb lead placement. In snakes they should be placed two heart lengths cranial and caudal to the heart (Figure 1).

Figure 1: Placement of electrodes in Electrocardiogram of Rescued rat snake.

Moreover, standard parameters are not established for many species, thus interval and segments values may not always be of much use. Performing routine ECGs on healthy patients can help to build up baseline values for future comparison. Interpretations of ECGs in reptiles are very similar to those in mammals, with P, QRS and T complexes. An SV wave represented by the depolarization of the sinus venosus (and the portocaval vein) may be measured just before the P wave. The SV wave is followed by sinal contraction, the P wave is followed by atrial contraction and the R wave is followed by ventricular contraction.

The T wave indicates ventricular repolarization. It should be noted that correct placement of the probe is primordial as bad positioning of the electrodes can influence ECG readings.

Currently, the interpretation of the ECG can be difficult because of limited reference material for comparison. In addition, the ECG can be influenced by various environmental factors.

For example, the heart rate is dependent on the body temperature, and the intervals such as the P-R and Q-T segments are influenced by the heart rate. To reduce the likelihood of misclassifying the results of an ECG, it is important to perform these tests under optimal conditions. In addition, performing routine ECGs on clinically normal reptiles can be helpful in establishing a baseline for comparison. The ECG should be used in addition to other diagnostic tests to confirm the presence of cardiac disease

Conclusion

Reptilian clinical cardiology is in its infancy. In the near future, it will be important for veterinarians to continue to collect and publish baseline reference material for the different diagnostic tests considered in this article, including ECG and echocardiology. Once this information is readily available, the practical usage of these tests for reptile cardiac case management should increase.

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