



Electrocardiographic Studies in Conscious Healthy Turtles

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ABSTRACT

The present investigation was carried out on 37 healthy conscious turtles, for establishing normal reference values of electrocardiographic parameters in standard lead II. ECG complexes were consisted of very small to imperceptible P wave, comparatively appreciable R wave, no Q or S waves, and imperceptible to small upright T wave. Broadly turtles' ECG was characterized by low amplitude wave forms, lower heart rate with longer periods of repolarization (QT interval). Heart rate varied from 22 to 48 beats per minute (32.27 ± 1.14 , median 32.0); P wave duration was 44.34 ± 3.63 ms (range 10-80, median 40 ms) and amplitude was 0.055 ± 0.003 mV (range 0.025 to 0.1, median 0.05 mV), 'R' wave was comparatively conspicuous (mean 0.194 ± 0.002 , range 0.025 to 0.7, median 0.25 mV), QRS pattern was positive and broad (mean 61.75 ± 2.75 , range 20-100, median 60 ms), 'T' wave was generally positive with a mean amplitude of 0.098 ± 0.0097 mV (range 0.05- 0.25, median 0.10 mV) and duration of 61.85 ± 3.66 ms (range 40-100, median 60 ms), Q-T interval was prolonged (mean 802.2 ± 51.45 , range 550-1280, median 800.0 ms) and longer R-R interval (mean 1859.31 ± 59.26 , range 1250-2727, median 1875). P and T waves were imperceptible in 14 and 10 turtles respectively.

Keywords: Electrocardiography, heart rate, hex-axial leads, turtle

Evaluation of heart is an integral part of detailed clinical examination in all species of animals. In turtles, hard shell (carapace and plastron) does not allow low amplitude heart sounds to be heard through auscultation. Hence, cardiac assessment is generally omitted in routine clinical examination of the turtles/tortoises by most of the Veterinarians. Assessing heart beat in turtles with respiratory or cardiovascular arrest is of vital importance. Heart beat can be determined and monitored using ultrasonic doppler flow probe, electrocardiogram and/or ultrasound. Electrocardiography is an invaluable technique that can be employed for monitoring cardiac function in turtles (Holtz and Holz, 1995).

As compared to canines and felines, electrocardiography in turtles is under developed and information is scanty (Cook and Westrom, 1979; Holtz and Holz, 1995). It is sparingly used in clinical practice because of limited understanding regarding its interpretation. Small number of observations in most of the studies (Mc Donald and Heath, 1971; Cook and Westrom, 1979) restrict usefulness

of electrocardiogram in the clinical examination of turtles. For the practical applicability of ECG in the diagnosis of cardiac ailments in chelonians (turtles, tortoises and terrapins), normal values for each species must be available. Though, electrocardiography is routinely employed for evaluation of heart in canines and felines, its application in chelonians and reptiles is yet to find routine place as diagnostic technique probably because of the scarcity of electrocardiographic reference values for healthy chelonian species.

In India turtles/tortoises are being increasingly kept as pet animal in urban settings. Though, turtles are sturdy animals, are also prone to respiratory and cardiac arrest under improper husbandry conditions and stress. It seems that cardiology in chelonians has remained a neglected area in veterinary medicine in India. No work seems to have been done on electrocardiography of turtles and snakes in India except a few case reports (Varshney and Chaudhury, 2014; Varshney, 2016). The present study was, therefore, designed to obtain basic electrocardiographic data from

healthy conscious pet turtles employing hex-axial lead system.

MATERIALS AND METHODS

Thirty seven clinically healthy turtles of both sex and varying weights (50 g to 1600 g), formed the material for the present study. The turtles were subjected to electrocardiography by placing ventral side up. For obtaining a standard bipolar lead ECG, needle electrodes/crocodile clips were attached in a modified Einthoven lead system. Yellow and red electrodes were attached to the proximal aspects of left and right fore limbs respectively; green and black electrodes were attached to the left and right hind limbs (Fig. 1) respectively. Magic RX electrocardiographic machine (Maestros Mediline Systems Limited) was standardized at 20 mm or 10 mm = 1 mV and at a speed of 25 mm per second and electrocardiogram was recorded in lead I, II, III, aVR, aVL and aVF leads at room temperature (28 -30 °C). The ECG tracing were analyzed for heart rate, amplitude and duration of 'P' wave, 'R' and 'T' waves; QRS, QT and R-R intervals. Statistical analysis was made using excel programme (website Vassarstats.net)

RESULTS AND DISCUSSION

Classically chelonian heart is a three chambered organ with two atrium and one ventricle (Johansen, 1959) and the pacemaker is situated in sinus venosus (Valentinuzzi, 1969). As compared to canines and felines information on reptile (including chelonians) electrocardiography is scanty (Cook and Westrom, 1969). Attempt had been made to record sequence of electromagnetic depolarization in snakes as the SV wave followed by sinus contraction, then the 'P' wave was followed by atrial contraction and finally 'R' wave followed by ventricular contraction (Valentineuzzi, 1969). Electrocardiography in snakes and turtles has not attracted enough attention of researchers in India except two recent reports (Varshney and Choudhary, 2014; Varshney, 2016). The present study was conducted on healthy conscious turtles restrained manually in dorsal decumbency without sedative or anesthetic. The measurements of different wave forms in lead II were considered for analysis because of their largest deflections. The mean ± SE, range and median values for electrocardiographic parameters of the healthy conscious

turtles are presented in the Table 1 and ECG tracings in different leads are given in Fig. 2. 'P' wave was positive and monophasic in lead II in 23 turtles while in rest it was not appreciable.

Table 1: Electrocardiographic indices in conscious healthy pet turtles

ECG indices	Range	Mean±S.E.	Median
Heart rate (bpm)	22-48	32.27±1.14	32.0
'P' amplitude (mV)	0.025-0.10	0.055 ±0.0033	0.05
'P' duration (ms)	10.0-80.0	44.34 ±3.63	40.0
QRS' amplitude (mV)	0.025-0.700	0.194 ± 0.002	0.25
'QRS' duration (ms)	20.0-100.0	61.75 ±2.75	60.0
Q-T interval (sec.)	550-1280	802.2±51.45	800
'T' amplitude (mV)	0.05-0.25	0.098 ±0.0097	0.10
'T' duration (ms.)	40.0-100.0	61.85 ±3.66	60.0
R-R interval (ms)	1250-2727	1859.31 ±59.26	1875.0

Bpm = Beats per minute, mV = milli volt, ms = milli second



Fig. 1: Placement of electrode in the turtle. The animal was placed ventral side up and yellow and red electrodes were attached to the proximal aspects of left and right fore limbs respectively; green and black electrodes were attached to the left and right hind limbs respectively

Its amplitude varied from 0.025 to 0.1 mV with a mean of 0.055±0.0033 mV and median of 0.05 mV. The mean

duration of 'P' wave was 44.34 ± 3.63 ms (range 10-80 ms and median 40.0 ms). 'Q' wave was not observed in any case. 'R' wave was comparatively large than other waves with a mean amplitude of 0.194 ± 0.002 mV (range 0.025 to 0.7 mV, median 0.25 mV) and duration of 61.75 ± 2.75 ms (range 20-100 ms, median 60.0 ms). Mean QRS' duration (61.75 ± 2.75) in the present study was less and differed from the values (107 ± 32 ms) reported by Kharin and Shmakov (2009) in anaesthetized six turtles. In turtles the 'QRS' was predominantly of 'r' type and its polarity was positive in lead II, III, aVF and negative in lead I, avR and aVL. The 'QRS' complex in lead I was very small. 'S' wave was also not detected in any case. 'T' wave was positive in lead I,II,III and aVF and negative in lead aVR and aVL and was appreciable only in 27 turtles. Its amplitude varied from 0.05 to 0.25 mV (mean 0.098 ± 0.0097 , median 0.10 mV) and duration varied from 40 to 100 ms (mean 61.85 ± 3.66 ms, median 60.0 ms). Repolarization phase was comparatively long with a mean Q-T interval of 802.2 ± 51.45 ms (range 550-1280 ms, median 800.0 ms), approximately 43.14 % of mean R-R interval (1859.31 ± 59.264 ms).

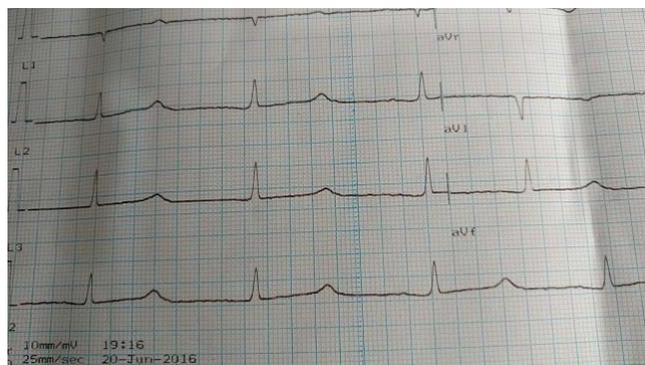


Fig. 2: Electrocardiogram of an adult male conscious pet turtle weighing 900 g, recorded at room temperature of 30 °C in Lead I, II, III, avR, avL and avF at paper speed of 25 mm/sec and machine set at 10 mm/mV. Lead II analysis revealed sinus rhythm with heart rate as of 40 bpm; very low amplitude (0.05 mV) but broad (60 ms) 'P'; P-R interval of 240 ms; low amplitude 'QRS' (0.7 mV, 80 ms); prolonged S-T interval (440 ms); + ve, small and broad 'T' (0.2 mV, 120 ms); prolonged Q-T interval (640 ms); and R-R interval as 1480 ms.

Still more longer Q-T interval has been reported by Holz and Holz (1995) and Kharin and Shmakov (2009). QT interval in the turtles is considerably longer than in mammalian species (Tilley, 1985). R-R interval was also

long and varying from 1250 to 2727 ms with a mean value of 1859.31 ± 59.264 ms and median of 1875.0 ms. Long Q-T and R-R intervals have also been reported in other species of reptiles (Shannon and Wigers, 1939; Johansen, 1959). Heart rate in the conscious turtles in the present study was on higher side as compared to that reported by Holz and Holz (1995) in anaesthetized red eared slider turtles (*Trachemys scripta elegans*). It correlated well with the observations of Kaplan and Schwartz (1963) in the conscious turtles. Heart rate in reptiles is influenced by various factors including body size, temperature, oxygen saturation of the blood, respiratory ventilation, postural or gravitational stress, haemodynamic equilibrium, and body sensory stimuli (Cabanac and Bernieri, 200).

In reptiles increased ambient temperatures are associated with increased heart rates and decreased stroke volumes (Marja and Mark, 2005). Variations in the heart rate of chelonians in different study may be related to different ambient temperatures at which ECG was done as heart rate is also influenced by environmental temperatures in reptiles. No Q and S waves in turtles' electrocardiogram were in agreement with observations of Kaplan and Schwartz (1963) and might be the reflection of single ventricle.

The amplitude of P,R and T waves (0.055 ± 0.0033 ; 0.194 ± 0.002 ; 0.098 ± 0.0097 mV) in conscious turtles were smaller than those reported in mammals (Tilley, 1985). 'P' and 'T' waves were too small in 14 and 10 turtles respectively to be measured. In India, no other work could be found to compare the present work. The electrocardiogram of the turtles appears similar to that of humans except low voltage of 'P', 'R' and 'T'; no 'Q' and 'S' waves and lower heart rate. This seems to be the first report on the electrocardiogram of the healthy conscious pet turtles in India.

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