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Determination the Normal Parameters (amplitude and duration) of Electrocardiogram Waves in River Buffaloes (Bubalus Bubalis) of Khuzestan

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Abstract

An easy way to evaluate the cardiovascular system is recording the cardiac electrical activities. Reviewing the available literatures suggests that buffalos ECG compared to other large animals have been neglected and the carried out studies in this field are too limited. Using this method for the diagnosis of cardiac disorders needs the standardization, not only among animal species but also among different breeds of a species. The present study was performed to determine the normal parameters of electrocardiogram in 100 clinically healthy buffaloes of different ages and sexes. The buffaloes were divided into male and female and two age groups (less than 2.5, and more than 2.5 yrs.) on the base of dental formula. After taking the anamnesis and performing a clinical examination, electrocardiogram was obtained based on base - apex lead system with the paper speed of 25mm sec-1 and sensitivity of 10 mm mV-1 at rest. Results showed that regardless of age and sex, the median and interquartile range of P, R, S and T waves' amplitude (voltage) was, 0.18±0.04, 0.69±0.40, 0. 97± 0.31 and 0.20 ±0.25 mV, respectively and the duration of p wave, QRS complex, and T wave was determined 0.06 ±0.01, 0.06 ±0.01 and 0.08 ± 0.02 seconds, respectively. Only in a less than 2.5 years old female buffalo, Q wave was recorded, the amplitude of this wave was 0.07 mV. Statistical method showed that among different ECG parameters, there was significant difference between the two sexes (p< 0.05), only in amplitude of S wave. Also there were significant differences between two age groups in all of the electrocardiogram parameters with the exception of P and R amplitude (p<0.05). It is concluded that the factors such as breed, ecology and behavior can affect normal electrocardiogram waves parameters.

Keywords: Electrocardiogram, Buffalo, Parameter, Khuzestan.

Introduction

Studying the cardiovascular system and distinguishing and differentiating the normal and abnormal states of this system is an important part of animal examination and a method to determine the cardiovascular system health. An easy way to evaluate the circulatory system is recording the heart electrical activity.

Many factors affect ECG parameters, some of which are pathological and some others non-pathological. Some non-pathological factors that can affect the waves amplitude are the characteristics of heart conductive system, the blood volume, the electrodes position, the quantity of muscle mass,

the size of the heart chambers, the chest wall thickness, and the chest shape (Amory et al., 1993).

The increase in the thickness of the chest wall can lead to a voltage drop in the electrocardiogram. As an example, we can mention the reduction in the wave's amplitude of the Double- Muscled calves due to the chest thickness (Amory et al., 1993). According to the study Conducted by Rezakhani and shahbazi (1996) on buffalo and compared to the studies that carried out on cattle, the amplitude of the electrocardiogram waves in the buffalo is lower than cattle, because the buffalo chest is wider than cattle's.

Many factors including breathing, the physical growth of the body, obesity or any factor that increases the pressure on the diaphragm can cause a change in heart position in the chest (Amory et al., 1993).

Reviewing the available literatures suggests that buffaloes ECG compared to other large animals have been neglected and the carried out studies in this field are too limited. Undoubtedly, the use of this method for the diagnosis of cardiac disorders needs the standardization, not only among animal species but also among different breeds of species. That is because the different characteristics of a breed can be associated with changes in different parameters of ECG.

Materials and Methods

One hundred buffaloes (Bubalus bubalis) from five Counties of Khuzestan province (Ahvaz, Shoshtar, Dezfoul, Shadegan and Sosangerd) were selected for this study. In each farm, after taking the anamnesis, all buffaloes were used for an ECG recording, providing that the animals were healthy with no clinical signs of any organ abnormalities and no treated or not taking medication in recent weeks. The ECGs were recorded outdoors and in season with low temperature changes in the morning from 9.00 to 12.00. Closer to the hot season, the same procedure but with shortening the morning test period starting from 9.00 AM was used. Each animal was kept in a standing position in a stock without any tranquilizer or sedative and given at least 5 to10 minutes to get relaxed. No clipping or shaving was carried out for electrodes attachment. A base apex bipolar lead was used for recording. Alligator types of electrodes were used for this recording. After cleaning the area with alcohol, the positive electrode was attached to the skin over the left fifth intercostal space just posterior to the olecranon and the negative one over the jugular furrow about 1/3 of the neck on the left side, and the earth electrode was attached away from these two electrodes. The attachment of the negative electrode on the left side of the neck was used as previously researched proved that there is no significant difference when attaching this electrode on the right or left side of the neck in the horse and cattle (Rezakhani et al., 1994). Electrocardiograms were taken for at least 2 minutes and all of them were obtained on a single channel battery driven machine (Fukuda Denshi, Tokyo, Japan) with the paper speed 25mm/sec and calibration of 10 mm equal to 1 mV. Each electrocardiogram was scanned by a scanner; then for reading the parameters zoom in was done.

At this stage, the amplitude of P, Q, R, S, and T waves and the duration of P, QRS, and T waves were measured and recorded. In each case whenever the amplitude of S, R and Q waves was smaller or equal to 0.05 mV, they were considered as small letters (s, r and q); otherwise the sizes more than 0.05 mV were considered as capital letters. The very small waves that were not properly visible were considered immeasurable (almost isoelectric). In each electrocardiogram, the average of the wave amplitude and duration for the 5 waves were considered as the final figure. The numbers

for this measurement are in millimeters; so, they were converted to desired units for the height and duration of the wave, respectively (voltage and seconds) and have been recorded in separate tables.

Statistical Methods

The data was analyzed by SPSS version 16. Kolmogorov-Smirnov test was used to determine normality of quantitative amounts. The test showed that the distribution of the various electrocardiographic parameters did not have a normality. Therefore, the results presented in the form of median ± interquartile range and were compared with Mann-Whitney U test. Also, the average and the standard deviation of these values were given in the related tables (Table1 and 2).

Results

In this study, regardless of age and sex, the median and interquartile range of P, R, S and T waves' amplitude were 0.18±0.04, 0.69±0.40, 0.97± 0.31 and 0.20 ±0.25 mV respectively and the duration of p wave, QRS complex, and T wave were 0.06 ±0.01, 0.06 ±0.01 and 0.08 ± 0.02 seconds respectively (Tables 1 and 2). Only in a less than 2.5 years old female buffalo, Q wave was recorded, the amplitude of this wave was 0.07 mV.

Electrocardiographic parameters and gender

In table 1, the various parameters of ECG waves of the examined animals are presented according to gender. Statistical tests showed that, among these parameters, only the amplitude of S wave has the significant difference between the two sexes ($p< 0.05$).

Electrocardiographic parameters and the age

Table 2 shows the various parameters of ECG waves in the studied Buffaloes based on age. According to the statistical analysis, there were significant differences between two age groups in all of the electrocardiogram parameters with the exception of P and R amplitude ($p<0.05$).

Discussion

The amplitude of P wave

In the present study, the median ± interquartile and the mean ± SD of the P wave amplitude were 0.18 ± 0.04 and 0.18 ± 0.05 mV respectively. There was no significant difference between the two sexes and age groups.

The P wave amplitude was reported as 0.05 mV and 0.05 ± 0.01 mV respectively by Jayaseraka et al. (1992) and Sobti et al. (1981) in buffaloes. Positive and negative P waves were 0.03 ± 0.01 and 0.15 ± 0.8 mV, respectively in Azerbaijan buffaloes (Rezakhani and Shahbazi, 1996). In a study with base- apex lead system, the P wave amplitude was 0.16 ± 0.03 mV (Suresh et al., 2009). Through a comparison between the results of the present study and the above-mentioned studies, it was determined that in studies which the base- apex lead were used for electrocardiography, the results were very similar. By using lead II and base- apex, Deroth (1980) reported the amplitude of P wave 0.09 and 0.11 mV, respectively, in cattle. Mendes et al (2001) reported the amplitude of P wave in two age groups of Holstein's calves, aged 18 -72 hours and 27- 33 days, 0.18 ± 0.11 and 0.13 ± 0.11 mV, respectively. In Mendes study, lead II was used and the difference between the age groups was not statistically significant. Rezakhani et al (2004), by using base- apex lead system, determined the P wave amplitude in 600 cattle as 0.12 ± 0.04 mV.

Table 1: median (± interquartile range) and mean (± SD) o f various electrocardiographic waves' indices on the sex basis in the studied buffaloes

Gender \ Parameter		P Height (mv)	R Height (mv)	S Height (mv)	T Height (mv)	P duration (Sec)	QRS duration (Sec)	T duration (Sec)
Female	Median ± interquartile range	0.18± 0.04	0.66± 0.33	0.70± 0.3	0.24± 0.20	0.07± 0.01	0.06± 0.01	0.08± 0.02
	Mean ± SD	0.17± 0.05	0.63± 0.39	0.83± 0.47 *	0.18± 0.29	0.07± 0.02	0.06± 0.02	0.08± 0.02
Male	Median ± interquartile range	0.19± 0.04	0.72 ± 0.39	1.17± 0.17	0.19± 0.23	0.06± 0.01	0.06± 0.01	0.08± 0.02
	Mean ± SD	0.18± 0.05	0.61± 0.41	1.17± 0.27	0.08± 0.39	0.06± 0.02	0.06± 0.02	0.08± 0.02
Total	Median ± interquartile range	0.18 ± 0.04	0.69 ± 0.40	0.97± 0.31	0.20± 0.25	0.06± 0.01	0.06± 0.01	0.08± 0.02
	Mean ± SD	0.18± 0.05	0.62± 0.40	0.98± 0.42	0.14± 0.29	0.06± 0.02	0.06± 0.02	0.08± 0.02

** The difference between the two sex groups is statistically significant (P<0.05).*

Table 2: The median (±interquartile range) and the mean (±SD) of various indices of ECG waves based on age of the studied buffaloes

Parameter / Age		P Height (mV)	R Height (mV)	S Height (mV)	T Height (mV)	P duration (Sec)	QRS duration (Sec)	T duration (Sec)
Equal or less than 2.5 years	Median ± interquartile range	0.17± 0.04	0.71± 0.40	1.17± 0.90	0.13± 0.22	0.06± 0.01	0.06± 0.01	0.07± 0.02
	Mean ± SD	0.17± 0.05	0.61± 0.43	1.18± 0.38 *	0.07± 0.29 *	0.06± 0.01 *	0.06± 0.02 *	0.08± 0.02 *
Older than 2.5 years	Median ± interquartile range	0.19± 0.04	0.66 ± 0.29	0.63± 0.16	0.26± 0.12	0.07± 0.01	0.07± 0.01	0.08± 0.02
	Mean ± SD	0.18± 0.05	0.63± 0.29	0.64± 0.24	0.23± 0.26	0.07± 0.02	0.07± 0.01	0.09± 0.02
Total	Median ± interquartile range	0.18 ± 0.04	0.69 ± 0.40	0.97± 0.31	0.20± 0.25	0.06± 0.01	0.06± 0.01	0.08± 0.02
	Mean ± SD	0.18± 0.05	0.62± 0.40	0.98± 0.42	0.14± 0.29	0.06± 0.02	0.06± 0.02	0.08± 0.02

** The difference between the two age groups is statistically significant (P<0.05).*

In their study, there was a positive significant relationship between age and the amplitude of P wave.

The amplitude of QRS complex

In the present study, the median ± interquartile of R and S waves amplitude were 0.69 ± 0.40 and 0.97 ± 0.31 mV and their mean ± SD were 0.62 ± 0.40 and 0.98 ± 0.42 mV, respectively.

Sobti et al. (1981), through a study on 22 healthy adult buffaloes with age range between 5-9 years, using lead II, reported the amplitude of Q and R waves as 0.14 ± 0.01 and 0.41 ± 0.03 mV, respectively. They could not measure the amplitude of S wave. Also, Lacuata and Libo(1983) reported amplitude of Q, R and S waves 0.3 ± 0.3, 0.3 ± 0.3 and 0.02 ± 0.06 mV, respectively. Rezakhani and Shahbazi (1996) reported the amplitude of R and S waves in their study as 0.1 ± 0.07 and 0.96 ± 0.28 mV, respectively and their study did not provide a value for Q wave amplitude.

Comparison between the above reports and the results of the present study showed an interesting similarity for the values of QRS complex amplitude. In a study on 600 cattle by Rezakhani et al (2004), only the mean and the standard deviation for R wave amplitude (0.15 ± 0.13 mV) and S-wave amplitude (0.77 ± 0.27 mV) were provided but Q wave amplitude was not considered (Rezakhani et al., 2004). This is true about a survey conducted on 32 cattle by Deroth(1980), in which study, the mean amplitude of R and S waves were 0.07 and 0. 8 mV, respectively but Q wave was not recorded.

The Statistical tests in the present study showed that, among the various components of the QRS complex, only S amplitude has a statistically significant difference between the two sexes and age groups. The S amplitude was higher in male buffaloes which are younger or equal to 2.5 years.

Rezakhani and Holmes have shown that age is one of the affecting factors on ventricular depolarization vector in human and cattle (Holmes and Rezakhani, 1975). Upadhyay et al. (1976), in a study on Jersey cattle, showed that the amplitude of different parts of QRS complex has changed due to cattle age but there is no clear trend in this regard. They recorded the maximum Q wave amplitude in very young cattle. In the conducted studies by Alidadi (1995) on the Turkoman horse and Taghavi (2007) on Khuzestan Arab Horse (Taghavi Razavizadeh, 2007), the S wave amplitude was bigger in males in some using leads.

The amplitude of T wave

In the present study, median ± interquartile and mean ± SD of T wave amplitude were 0.20 ± 0.25 and 0.14 ± 0.29 mV, respectively. In Sobti et al (1981) study T wave amplitude was 0.13± 0.02 mV. During a survey on 107 river buffaloes, T wave amplitude was measured as 0.2 ± 0.14 mV (Lacuata and Libo, 1983). In another study on three buffaloes, the value of this parameter was the 0.3 mV (Jayasekera et al., 1992). Rezakhani and Shahbazi (1996) determined the T wave amplitude as 0.22 ± 0.11 mV (in the positive waves) and -0.12 ± 0.07 mV (in the negative waves). T wave amplitude was 0.21 ± 0.05 mV in the study of Suresh et al. (2009). In another study, the mean amplitude of T wave in cattle was reported as 0.47 mV (Deroth, 1980). Rezakhani et al (2004) have announced 0.25 ± 0.14 mV for the amplitude of positive T waves and -0.12 ± 0.10 mV for the amplitude of negative T waves in cattle.

Some researchers believe that due to considerable variability in T wave amplitude in healthy animals, it cannot be used as a indicator for assessment the health of animals (Edwards and Trieb, 1993).

In the present study, the T wave amplitude in animals which are older than 2.5 years was significantly more

than in those less than or equal to 2.5 years' age group. Also, in a study on khuzestan Arab horses, it has been observed that the age differences influenced the amplitude of T wave (Taghavi Razavizadeh, 2007).

The duration of waves

The duration of ECG waves like their amplitude may also be influenced by physiological and pathological factors (Edwards and Trieb, 1993). For example, in small animals, the block of left bundle branch induces the increase of the duration of QRS complex (Edwards and Trieb, 1993). It is said that increased sympathetic tone can reduce the duration of the P wave. Thus, the mental condition of animals should be considered in evaluating the duration of this wave (Piccion et al., 2003).

Duration of P wave

In the current study, the median ± interquartile and the mean ± SD of the duration of the P wave were 0.06 ± 0.01 and 0.06 ± 0.01 seconds, respectively.

In the two studies conducted on the buffaloes using base- apex lead system, P wave duration were 0.08 ± 0.02 seconds (Rezakhani and Shahbazi, 1996) and 0.07± 0.01 seconds (Suresh et al., 2009). Ghita et al. (2008) have determined the duration of P wave in 46 dairy cattle aged 4-9 years old as 0.09 ± 0.002 seconds. They used lead II for their electrocardiography. In a study by Deroth (1980), mean of P wave duration for the examined cattle was 0.1 ± 0.11 in lead II and 0.1 ± 0.01 in base- apex lead.

In the present study, the differences between P wave duration were significant only between the two age groups as the older animals had longer P-wave duration. This finding can be attributed to size of atrium in bigger buffalo because when the atrium is bigger, the duration of the wave representing the depolarization of this part of the heart (wave P) will increase.

The above finding is observed in other studies conducted on Buffaloes (Lacuata and Libo, 1983), cattle (Upadhyay et al., 1976) and horses (Taghavi Razavizadeh, 2007). Unlike the above studies, in a study by Sud and Upadhyay (1982), no significant statistical differences were observed between P wave duration of different age groups (1-2 years, 2-3 years, and 3-6 years).

Duration of QRS complex

In the present study, the median ± interquartile and the mean ± SD of QRS complex duration were 0.06 ± 0.02 and 0.06 ± 0.02 seconds respectively.

In a study conducted on three buffaloes, the duration of QRS complex was 0.07 ± 0.01 seconds and the mean ± SD of QRS complex duration for the cattle was 0.04 ± 0.01 seconds (Jayasekera et al., 1992). In another study conducted on buffalo, using base- apex lead system, the QRS complex duration was 0.09 ± 0.01 seconds (Rezakhani and Shahbazi, 1996; Suresh et al., 2009).

The two studies on cattle showed the values of QRS complex duration in lead II, 0.08 ± 0.002 (Ghita et al., 2008) and 0.06 ± 0.01 seconds (Mendes et al., 2001). In others researches on this animal, using base- apex lead system, the mean ± standard deviation of QRS complex duration was 0.06 ± 0.01 (Rezakhani et al., 2004) and 0.12 ± 0.01 seconds (Deroth, 1980).

In this study, only the difference of duration of QRS complex between the two age groups was statistically significant. This finding has also been observed in studies of Lacuata et al. (1983) in buffaloes and Rezakhani et al (2004) in cattle.

In horse medicine, several factors such as the age, the autonomic nervous tone, electrolyte balance and

the heart damage are considered to have an influence on QRS duration. In order to explain the observed differences in QRS complex duration of different studies, in addition to the above points, physical status and differences in breed should also be considered (Physick et al., 1983). It seems that many of the above points are true about the buffalo.

Duration of T wave

The median ± interquartile and the mean ± SD of the T-wave duration of buffalo in this study are similar and equal to 0.08 ± 0.02 seconds.

In Upadhyay and Sudy's (1982) research, the duration of T waves in 3-6 years old buffaloes were determined as 0.1 seconds. In a study on 107 river buffaloes, the mean ± SD of this wave was 0.12 ± 0.04 second (Lacuata & Libo, 1983). Suresh et al. (2009) reported 0.08 ± 0.01 seconds for this parameter in their study. Rezakhani and Shahbazi (1996), by using base-apex lead system, found T wave duration to be 0.09 ± 0.02 seconds, which is very close to findings of the present study.

The mean ± SD of the T wave duration of cattle has been reported as 0.85 ± 0.002 (Ghita et al., 2008), 01/0 ± 09/0 (Rezakhani et al., 2004) and 02/0 ± 11/0 2 (Deroth, 1980).

In this study, the T-wave duration for those animals which are older than 2.5 years was more than animals which were younger than this age. The results of a study on Khuzestan Arab horse were also similar to the results obtained in the present research (Taghavi, 2007).

Conclusion: It is concluded that the factors such as breed (which affect the size of heart cavities and the heart axis anatomical location), ecology and behavior cause the difference which observed in some results of this study and those reported by others.

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تعیین پارامترهای طبیعی (ارتفاع و دامنه) امواج الکتروکاردیوگرام در گاومیش رودخانه‌ای خوزستان (*Bubalus Bubalis*)

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ثبت فعالیت الکتریکی قلب از جمله روش‌های آسان جهت ارزیابی دستگاه گردش خون می‌باشد. از بررسی منابع قابل دسترس چنین برمی‌آید که الکتروکاردیوگرافی گاومیش در مقایسه با سایر دام‌های بزرگ مورد غفلت قرار گرفته و مطالعات انجام شده در این مورد بسیار محدود می‌باشد. به کار بردن این روش جهت تشخیص اختلالات قلبی نیازمند استاندارد نمودن آن نه تنها در بین انواع دام بلکه در میان نژادهای مختلف از یک‌گونه می‌باشد. چرا که ویژگی‌های مختلف نژادی می‌تواند با تغییر در پارامترهای مختلف یک الکتروکاردیوگرام همراه گردد. تحقیق حاضربا هدف تعیین پارامترهای طبیعی الکتروکاردیوگرام روی ۱۰۰ رأس گاومیش رودخانه‌ای به ظاهر سالم از گروه های جنسی و سنی مختلف صورت گرفته است. گاومیشها به دو گروه نر و ماده و نیز دو گروه سنی(کمتراز ۲/۵ سال و بیشتر از ۲/۵ سال) بر اساس فرمول دندانی تقسیم شدند. پس از گرفتن تاریخچه و انجام معاینات بالینی الکتروکاردیوگرام با استفاده از لید قاعده ای – راسی و با سرعت ۲۵ میلیمتر بر ثانیه و حساسیت ۱۰ میلی ولت بر دقیقه ودر حال استراحت ثبت شد. نتایج نشان داد که بدون توجه به سن و جنس میانه و دامنه بین چارکی ارتفاع امواج S,R,P و T به ترتیب ۰/۰٤± ۰/۱۸، ۰/۰٤۰±۰/٦۹, ۰/۳۱± ۰/۹۷ و ۰/۲۵ ±۰/۲۰ میلی ولت و دامنه (مدت زمان) موج، P کمپلکس QRS وموج T به ترتیب۰/۰۱± ۰/۰٦, ۰/۰۱± ۰/۰٦و ۰/۰۲± ۰/۰۸ ثانیه می‌باشد. تنها در یک راس گاومیش ماده نابالغ موج Q ثبت شد، ارتفاع این موج ۰/۰۷ میلی ولت گزارش گردید. آزمونهای آماری نشان داد که در میان شاخص‌های مختلف الکتروکاردیوگرام تنها ارتفاع موج S تفاوت معنی‌داری را دربین دو گروه جنسی نشان داد(۰/۰۵ >p) و در میان دو گروه سنی تفاوت آماری معنی‌دار در تمامی پارامترهای الکتروکاردیوگرام بجزارتفاع P و R وجود داشت(۰/۰۵ >p) نتیجه‌گیری میگردد که عواملی مانند نژاد، اقلیم و رفتارهای گاومیش می‌تواند روی پارامترهای نرمال امواج الکتروکاردیوگرافی تاثیر گذار باشد.

واژه‌گان کلیدی: الکتروکاردیوگرام، گاومیش، پارامتر، خوزستان