Short Communication

The electrocardiogram of the conscious Chinese goose (*Anser cygnoides*)

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Abstract

This study was carried out on 24 healthy adult Chinese goose (*Anser cygnoides*) to determine normal electrocardiographic values and patterns in standard bipolar and augmented bipolar limb leads. The study between males and females was also performed to investigate changes in the electrocardiographic patterns related to sex. A regular sinus rhythm was observed in all birds. There was no significant difference between male and female geese except for PR interval, therefore, all data was pooled. All waves in lead I had very low amplitude or almost isoelectric. The P waves, in other leads, were mainly positive in lead II, III and aVF, negative in lead aVR and biphasic in lead aVL. The all waveforms of the QRS complexes (approx. -0.90 mV and 0.03 seconds in lead II) were rS in lead II, III and aVF, and qR in lead aVR and aVL. The T waves (approx. 0.31 mV and 0.06 seconds in lead II) were totally positive in lead II, III and aVF, and negative in aVR and aVL. The majority of birds showed a ST slurring and slightly elevated ST segment in lead II. Heart rates were 142 ± 25 (Mean ± SD) beats per minute and mean electrical axes were -90.88±4.57° in geese. This study provides electrocardiographic data for Chinese goose, which can be used for clinical purposes.

Keywords: *Anser cygnoides*, Chinese goose, Electrocardiography, Heart rate, Mean electrical axis

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Introduction

Electrocardiography (ECG) which is the non-invasive record of the electrical activity generated by the heart has been extensively used for diagnostic or research purposes in both human and animal species for more than a century. Despite the first ECG recorded in 1909 (Buchanan, 1909) and 1948 (Sturkie, 1948) in avian and poultry, respectively, there is no sufficient data such as has been accumulated for humans and, to a lesser extent, other mammals. There is no or little report on electrocardiography in poultry. The findings of ECG are commonly used for accurate cardiac diagnosis in various poultry species such as chicken (Kisch, 1951; Olkowski et al., 1997), turkey (McKenzie et al., 1971; Boulianne et al., 1992), duck (Kisch, 1951; Cinar et al., 1996), goose (Emre et al., 1994) and other avian species (Kisch, 1951; Nap et al., 1992; Casares et al., 2000; Uzun et al., 2004; Onder et al., 2006; Talavera et al., 2008; Kaya and Soylu, 2013). There is only one study of electrocardiography in goose and none in Chinese goose.

Chinese geese are a breed of domesticated goose descended from the wild swan goose, which are one of the most popular and well known breeds of domestic goose. Chinese geese appear in two varieties: a brown, similar to the wild swan goose, and white. They are relatively small. Mature males weigh 5.0 kg and females weigh 4.0 kg in average. However, these geese are among the most prolific breeds, with each goose laying between 40 and 100 eggs a year, which is twice the average production of other goose breeds. Because of their foraging ability, Chinese geese do not need to be fed while they are on pasture. If sufficient forage is available, the breeders might not need to feed them, except during fall and winter. Therefore, Chinese geese are preferred by many breeders in the world due to their ability to yield high eggs and to be able to use poor quality pasture as a feed source (Tilki and Saatçi, 2013).

The aim of this current study was to establish the ECG patterns in Chinese geese, and to obtain information in the heart rate and rhythm, the duration and amplitude of ECG deflections, and the mean electrical axis in this goose breed. The findings obtained from this study might be useful to evaluate cardiac situation and to serve as reference values for later studies in this species.

Materials and Methods

Animals: In this study, a total of 24 mature Chinese geese (*Anser cygnoides*) of both sexes (12 males, 12 females) raised by local farmers were used. Geese were 8-24 months old and the average body weights of male and female geese were 3996 g and 3790 g, respectively. The geese were clinically healthy. The present study was conducted in Samsun district (latitude 41° 21′ N, longitude 36° 45′ E) and was approved by the Ondokuz Mayis University Local Ethical Committee for Animal Studies (Approval no: 2015/32).

ECG Recording: ECG recording process was performed at the same time of the day (10:00-12:00) to eliminate changes derived from biorhythms. To minimize stress, all the procedures were carried out in their native environments. The geese were immobilized by wrapping a light cloth around them and birds' heads were covered with a thin cloth during the manipulation. The geese were gently placed in ventral recumbency on a wooden table covered with rubber material. Throughout the recordings neither sedation nor anaesthesia were used. Electrocardiograms were recorded with a battery-operated electrocardiograph (Cardiette, ar600adv, Italy). Atraumatic alligator clip electrodes were attached to the skin after gel application at the base of the wings and to the skin overlying the stifle on the right and left sides. To provide a calming period for the goose, ECG recordings started approximately 1-2 minutes after the electrode placement. When birds were completely quiet and relaxed, limb leads were recorded. All electrocardiograms were recorded with speed set at 50 mm/sec and voltage of 1 mV=10 mm. The lead II which was selected for the measurement of amplitude and duration of waves recorded for at least 60 seconds and all the other leads for 20-30 seconds. The QRS waveforms were labelled according to the standard nomenclature. Lead I had no or low amplitude in all birds, therefore mean electrical axis (MEA) was calculated by using lead II and III as described by Edwards (1993). The morphologic patterns of P, QRS and T waves were evaluated for each lead.

Statistical analysis: Mean, standard deviation (SD), minimum and maximum values were calculated by using the SPSS statistical package (IBM SPSS Statistics, Ver. 21, USA). Data are presented as mean±SD. The effect of sex was examined by independent samples t test. A value of $P<0.05$ was considered to be statistically significant.

Results and Discussion

Electrocardiographic examination is one of the methods most commonly used for detecting cardiac arrhythmias in avian and poultry species (Lumeij and Ritchie, 1994); however, it has been reported that ECG parameters can vary among species of birds (Miller, 1986; Nap et al., 1992; Cinar et al., 1996; Talavera et al., 2008).

The vast majority of electrocardiograms were obtained without major artefacts. A regular sinus rhythm was observed in all geese. A representative ECG of a goose is shown in Fig 1. There was only a statistical difference in PR interval between male and female goose. So, values of male and female geese were pooled and sex was ignored in the discussion.

We could obtain only one study on ECG in geese, and duration of P, QRS and T wave obtained from Chinese geese in our study were similar to those of reported by Emre et al. (1994) in Romanov geese. On the other hand, amplitude of P (0.17 mV) and QRS (-0.89 mV) wave in Chinese geese was higher than those of Romanov geese. While PR interval (0.10 sec) was higher in our study than reported for Romanov geese, QT interval (0.14 sec) was higher in Romanov geese than Chinese geese.

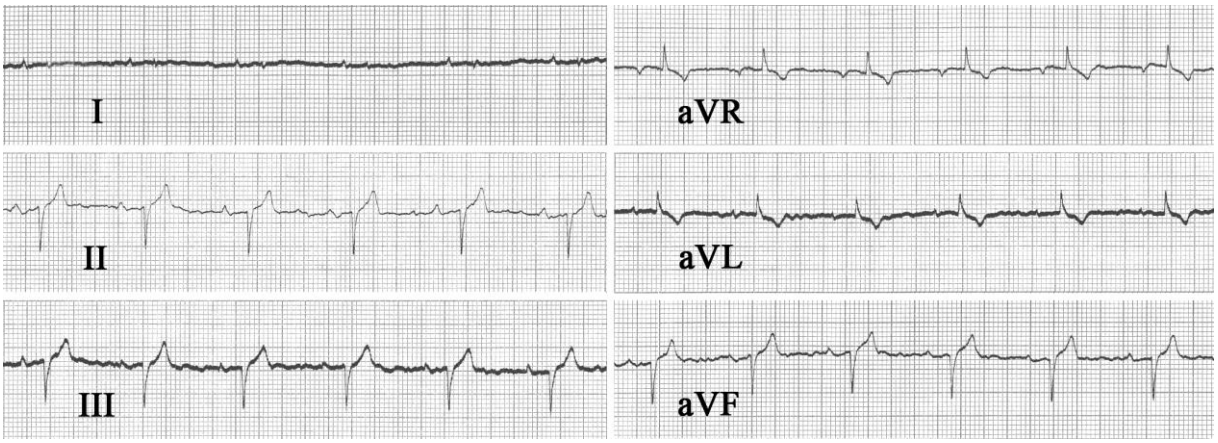

Figure 1 Representative electrocardiogram of a female goose in six leads. Standardization: 20 mm= 1 mV; chart speed= 50 mm/s.

The P waves were mostly positive in lead II, III and aVF, negative in lead aVR and biphasic (+/-) in lead aVL. Morphologic patterns of P and T waves and QRS complex were given in Table 1. In this respect, there is compatibility between our results and those findings reported by Emre et al. (1994) for Romanov geese and McKenzie et al. (1971) for turkey. On the other hand, Cinar et al. (1996) and Hassanpour and Khadem (2013) found that the P waves were mainly positive in all leads in Muskovy ducks and Pekin ducks, respectively. The amplitude of P wave in our study was higher than the value described by McKenzie et al. (1971) for turkeys and Emre et al. (1993) for chickens; lower than the value notified by Hassanpour and Khadem (2013) for Muskovy ducks and, similar to the value reported by Cinar et al. (1996) for Pekin ducks and Sturkie (1949) for chickens. The mean P wave durations in lead II were calculated as 0.04 seconds in the current study, which was fairly similar to the values reported for turkeys (McKenzie et al., 1971) and was higher than those of reported for Pekin ducks (Cinar et al., 1996) and chickens (Sturkie, 1949; Emre et al., 1993). The amplitude and duration of waves, duration of intervals, average heart rate and MEA values were presented in Table 2.

Table 1 Morphologic patterns of P and T waves and QRS complex in standard bipolar and augmented unipolar limb leads in geese (Values are given number of 24).

	P wave				QRS Complex			T wave		
Leads	**Pos**	**Neg**	**Iso**	**Bip**	**Iso**	**rS**	**qR**	**Pos**	**Neg**	**Iso**
I	1	0	23	0	24	0	0	1	0	23
II	24	0	0	0	0	24	0	24	0	0
III	15	0	2	7	0	24	0	24	0	0
aVR	0	23	1	0	0	0	24	0	22	2
aVL	1	1	6	16	0	0	24	0	21	3
aVF	20	0	4	0	3	21	0	21	0	3

Pos: positive, Neg: negative, Iso: isoelectric, Bip: biphasic (+/- or -/+).

Table 2 Amplitudes and durations of P, QRS and T waves and durations of P-Q/P-R, Q-T intervals and S-T segment, and heart rates and electrical axis in geese.

	P wave		P-Q/P-R interval	QRS complex		T wave		Q-T interval	S-T segment	BPM	MEA
	Amp	**Dur**		**Amp**	**Dur**	**Amp**	**Dur**				
Mean	0.17	0.04	0.10	-0.89	0.03	0.31	0.06	0.13	0.04	142.71	-90.88
SD	0.04	0.01	0.02	0.20	0.01	0.08	0.01	0.02	0.01	25.26	4.57
Min	0.10	0.03	0.05	-1.45	0.02	0.18	0.04	0.08	0.02	103.0	-101.0
Max	0.25	0.06	0.14	-0.50	0.04	0.50	0.10	0.20	0.08	203.0	-82.0

The amplitudes and durations are given in millivolt and second, respectively. SD: standard deviation, Min: minimum value, Max: maximum value, Amp: amplitude, Dur: Duration, BPM: beats per minute, MEA: mean electrical axis (°)

In our study, the QRS polarity was always positive in lead aVR and aVL, and negative in lead II, III and aVF. The QRS complex in lead I was either very low or isoelectric, therefore quantitative data for this

wave was not obtained. The deflection of QRS complex in leads II, III and aVF was exactly identified as the rS type. Likewise, in lead aVR and aVL the most frequent morphologies were qR. Our findings were almost similar to results obtained in many studies for rS form in lead II, III and aVF (McKenzie et al., 1971; Emre et al., 1994; Cinar et al., 1996; Hassanpour and Khadem, 2013) and qR form in lead aVR (McKenzie et al., 1971; Emre et al., 1994). While form of QRS complex in lead aVL was qR in our study, it was reported as R for turkeys (McKenzie et al., 1971) and Muskovy ducks (Hassanpour and Khadem, 2013), and r for Romanov geese (Emre et al., 1994). Although the Q wave cannot be seen in the chicken ECG (Sturkie, 1949; Emre et al., 1993), the Q wave in goose ECG was seen in 100% of leads aVR and aVL in our study. There was no Q wave seen in other leads of any goose. These results are confirmed by other ECG study in Pekin ducks (Cinar et al., 1996). However, there are researches that reported that Q wave are only observed in lead aVR for turkey (McKenzie et al., 1971) and Romanov geese (Emre et al., 1994), and aVL in Muskovy ducks (Hassanpour and Khadem, 2013). The mean values of duration and amplitude of QRS complexes were almost similar to those previously reported in turkeys (McKenzie et al., 1971), Pekin ducks (Cinar et al., 1996) and Romanov geese (Emre et al., 1994), but were much fewer than those of Muskovy ducks (Hassanpour and Khadem, 2013) and much greater than those in chickens (Sturkie, 1949).

The T waves were always positive in lead II, III and aVF, and always negative in lead aVR and aVL. It was isoelectric in lead I. These findings of T wave morphology were firmly similar to those reported previously in various poultry species (McKenzie et al., 1971; Emre et al., 1993; Emre et al., 1994; Cinar et al., 1996; Hassanpour and Khadem, 2013). The amplitudes of T wave in our study were slightly higher than those reported earlier in turkeys (McKenzie et al., 1971), ducks (Cinar et al., 1996; Hassanpour and Khadem, 2013) and chicken (Emre et al., 1993), but were similar to those in Romanov geese (Emre et al., 1994). The mean duration of T wave was 0.06 seconds in our study. The result was exactly similar to the finding in Romanov geese (Emre et al., 1994). Otherwise, McKenzie et al. (1971) mentioned that T wave durations in turkeys were 0.07 seconds, which was higher than our values. Cinar et al. (1996) reported that the duration of T wave in Pekin ducks was approximately 0.05 seconds, which is lower than our values.

A normal sinus rhythm was assessed in all geese and no remarkable arrhythmia was found in our study. The mean heart rate was 143 per minute and ranged from 103 to 203. However, in this study, the heart rate of Chinese geese was determined to be lower than those of turkeys (McKenzie et al., 1971), Pekin ducks (Cinar et al., 1996) and chickens (Emre et al., 1993; Pampori and Iqbal, 2007), but similar to that of Romanov geese (Emre et al., 1994).

The mean electrical axis of ventricular depolarization in birds is negative because the depolarization wave begins subepicardial and then spreads through the myocardium towards the endocardium (Kisch, 1949). In accordance to this expression, the MEA was negative in all birds with a value of -90.88°. The MEA values obtained from Chinese geese in this current study were exactly similar to previous reports in Romanov geese (Emre et al., 1994) and Muscovy ducks (Hassanpour and Khadem, 2013), but slightly lower than those in chickens (Emre et al., 1993; Pampori and Iqbal, 2007). Interestingly, contrary to all these values, the MEA has been reported as positive (+147°) for Pekin ducks (Cinar et al., 1996).

The ST segment is normally isoelectric. The normal ST segment may be slightly elevated above or depressed below the baseline. The amount of the elevation or depression is considered as abnormal when it is greater than 0.2 mV for dogs and 0.1 mV for cats (Edwards ,1993), but there is no reported criterion for ST segment elevation and depression in any avian species. As another abnormal situation, ST segment slurring may be seen when the ST segment goes directly into the T wave without first straightening out of the baseline, which ST slurring is frequently described with an undetermined cause in healthy birds (Lumeij and Ritchie, 1994; Lopez et al., 2005). Although there is no report in poultry that ST slurring or ST elevation has been seen, the ST segment has been frequently identifiable in all lead II in our study, and ST slurring and ST elevation was determined in half of them.

In conclusion, electrocardiographic data obtained from conscious Chinese geese show similarities and differences with the other poultry studied previously. Hopefully, The ECG values and patterns derived from these clinically normal geese will contribute to the formation of the reference value pool to help the diagnosis of cardiovascular abnormalities in this species for clinicians.

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บทคัดย่อ

คลื่นไฟฟ้าหัวใจของห่านจีนที่มีสติ (*Anser cygnoides*)

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การศึกษานี้กระทำในห่านจีน (*Anser cygnoides*) โตเต็มวัยที่มีสุขภาพดี จำนวน 24 ตัว เพื่อหาค่าปกติของคลื่นไฟฟ้าหัวใจและลักษณะของคลื่นไฟฟ้าหัวใจใน lead แบบบสองขั้วและแบบขั้วเดียว การศึกษานี้ได้เปรียบเทียบลักษณะของคลื่นไฟฟ้าหัวใจระหว่างเพศด้วย การศึกษานี้พบว่าห่านทุกตัวมีการเต้นของหัวใจปกติ ลักษณะของคลื่นไฟฟ้าหัวใจไม่มีความแตกต่างกันระหว่างเพศยกเว้นระยะ PR ดังนั้นค่าต่างๆ ที่นำเสนอจึงเป็นค่าเฉลี่ยรวมทั้งสองเพศ คลื่นไฟฟ้าหัวใจใน lead I มีความสูงน้อยสุดและเกือบจะชิดเส้น isoelectric line คลื่นไฟฟ้าหัวใจ P wave ส่วนใหญ่อยู่ในทิศทางบวกใน lead II, III, และ aVF เป็นลบใน lead aVR และเป็น biphasic ใน lead aVL ลักษณะของคลื่น QRS complex (สูง -0.90 มิลลิโวท์ และกว้าง 0.03 วินาที ใน lead II) เป็น rS ใน lead II III และ aVF เป็น qR ใน lead aVR และ aVL ลักษณะของคลื่น T wave (สูง 0.31 มิลลิโวท์ และกว้าง 0.06 วินาที ใน lead II) เป็นบวกใน lead II III และ aVF เป็นลบใน lead aVR และ aVL ห่านส่วนใหญ่มีลักษณะของ ST segment ค่อยๆ ลาดลง มียกสูงเล็กน้อยใน lead II อัตราการเต้นของหัวใจอยู่ที่ 142 ± 25 ครั้งต่อนาที และมี mean electrical axis อยู่ที่ -90.88±4.57° การศึกษานี้นำเสนอลักษณะปกติของคลื่นไฟฟ้าหัวใจในห่านจีนซึ่งสามารถนำไปใช้ในทางคลินิกได้

คำสำคัญ: *Anser cygnoides* ห่านจีน คลื่นไฟฟ้าหัวใจ อัตราการเต้นของหัวใจ Mean electrical axis

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