Iranian Journal of Veterinary Research, Shiraz University, Vol. 11, No. 3, Ser. No. 32, 2010

Effects of age on the prevalence of cardiac dysrhythmias in ponies

Rezakhani, A.[1*]**; Pirie, R. S.**[2] **and Blissitt, K. J.**[2]

[1]Department of Clinical Sciences, School of Veterinary Medicine, Shiraz University, Shiraz, Iran; [2]Department of Clinical Sciences, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Easter Bush Veterinary Centre, Roslin, Midlothian UK, EH25 9RG, England

[*]**Correspondence:** A. Rezakhani, Department of Clinical Sciences, School of Veterinary Medicine, Shiraz University, Shiraz, Iran. E-mail: a.rezakhani@ias.ac.ir

(Received 23 Sept 2009; revised version 13 Apr 2010; accepted 28 Apr 2010)

Summary

This study describes the prevalence of cardiac dysrhythmias occurring over a single 24 h period in ponies and compares the heart rate and frequency of dysrhythmias in two groups of ponies of different ages. Electrocardiograms were recorded using a Holter monitoring system from twenty four ponies aged less than 15-year-old (n = 14) and greater than 15-year-old (n = 10). Subsequent analyses of cardiac rhythm revealed that only 3/24 ponies maintained a regular rhythm throughout the recording period. In the remaining 21 ponies, 6 different types of dysrhythmias were detected, the majority of which were vagally mediated; sinus arrhythmia (n = 12), sinoatrial block (n = 6) and second degree atrioventricular block (n = 10). Premature beats of both atrial (n = 3) and ventricular (n = 1) origin were observed only in the older group. There were no significant differences between the 2 groups with respect to mean 24-h heart rates or the prevalence of cardiac dysrhythmias.

Key words: Heart, Dysrhythmia, Holter monitoring, Pony

Introduction

The resting heart rate decreases with age in normal healthy human beings (Jose and Collison, 1970) and other species (Alings and Bouman, 1993). This age related decrease in heart rate in elderly human beings is associated with an increased prevalence of atrial dysrhythmias thought to be due to changes in the connexin proteins in the gap junctions of the sinoatrial node (Jones, 2006). The maximal heart rate achieved during exercise in Thoroughbred racehorses also decreases with age (Betros *et al*., 2002; Vincen *et al*., 2006). An increased incidence of atrial fibrillation has also been reported in older horses in relation to myocardial lesions (Else and Holmes, 1971), although a recent study of dysrhythmias during and after treadmill exercise in poorly performing racehorses showed no significant associations between age and dysrhythmias (Jose-Cunilleras *et al*., 2006).

Dysrhythmias in horses are easily diagnosed by electrocardiographic examination (Gatti and Holmes, 1990) and there have been numerous reports in the veterinary literature describing both normal and abnormal ECG findings (Norr, 1913; Irvine, 1975; Hilwig, 1977; Holmes, 1980; Vibe-Petersen and Nielsen, 1980; Costa *et al*., 1985; Reef, 1989) and the prevalence of dysrhythmias in different equine populations (Reef, 1989, 1999; Yamamoto *et al*., 1992). The prevalence of cardiac arrhythmias is not only dependent on the horse population studied but also on the recording method used (Reef, 1999; Bonagura and Reef, 2003). The majority of equine dysrhythmias are vagally-mediated, thus any increase in sympathetic drive associated with patient restraint may prevent their occurrence during a routine ECG examination. In addition, sporadic dysrhythmias may occur out of the recording period of a routine, short duration ECG examination and may thus remain undetected (Kiryu *et al*., 1999). The advent of radiotelemetry, as well as permitting ECG recording periods of exercise, facilitated ECG recording throughout periods of minimal or no patient restraint (Hill *et al*., 1977; Scheffer *et al*., 1995). Methods permitting prolonged periods of ECG recording have also become available, and in their use reported on horses, online computer technology was initially used (Holmes, 1972), then Holter monitors using tape recorders (Raekallio, 1992; Reef *et al*., 1993) and lately, systems using blue tooth and memory card technology have become available. The prevalence of atrial dysrhythmias and atrioventricular block in horses is higher when the ECG is recorded by a Holter monitor over a prolonged period than when routine rhythm strips are recorded (Reef, 1999; Bonagura and Reef, 2003).

Cardiac dyshythmias are reported to be less common in ponies compared with horses (Buss *et al*., 1975; Rezakhani, 1978; Machida *et al*., 1992); however there are no reports to date of long-term ECG monitoring in ponies. This study was undertaken to determine the prevalence of cardiac dysrhythmias in ponies by continuous ECG recording over a 24 h period and also the influence of age on heart rate and the presence of cardiac dysrhythmias in ponies.

Materials and Methods

Animals

Twenty four ponies (14 males and 10 females), of various breeds and ages were studied. None of the females were pregnant. The ponies were either provided by local riding schools specifically for the study or were cases referred to the Easter Bush Veterinary Centre (School of Veterinary Sciences, University of Edinburgh) for euthanasia due to age- related diseases. Client consent to monitor the ECG over a 24 h period was obtained in all cases. All animals with painful conditions or diseases likely to influence resting heart rate were not included in the study.

For the purpose of the investigation of age-related cardiac findings, ponies were divided into two age groups; group 1: <15-year-old (median age-8 yrs, range 4-11; n = 14) and group 2: >15-year-old (median age-27.5 yrs, range 19-33; n = 10). The upper and lower limit of groups 1 and 2, respectively was based upon a previous demographic study of the equine population of northern Britain, in which it was found that the equine population is stable up to 15 years of age, after which there is a steady decline in numbers (Mellor *et al*., 2001).

Pre-recording preparation and data collection

Ponies were acclimatized to the recording location (5 m × 4 m loose box) for a minimum of 5 h before the start of recording. During the acclimatization period, hair was clipped from the 5 anatomical sites used for electrode placement; these included 2 areas on the left side of the withers (for positive electrode placement), 2 areas on the left hemithorax level with the elbow at the fifth or sixth intercostal space (for negative electrode placement; Fig. 1) and one location for the earth electrode. Following cleansing of the above 5 areas with alcohol, soft adhesive electrodes were applied (Cardiacare Ltd, Romford, Essex, UK) and connected to the respective leads from the Holter monitor receiver (Unolter, Novacor S.A., 4 Passage Saint-Antonine, 92508 Rueil-Maimaison, Cedex, France), which was placed within a pocket on a curcingle fixed around the girth area. A rug was placed over the equipment and secured with an anti-cast roller. The Holter monitor had two bipolar lead systems.

Fig. 1: Position of electrodes for recording ECG by Holter monitoring

Each recording commenced at 10.00 and throughout the following 24 h, a continuous digital ECG recording was obtained and stored on a flash memory card. Following the recording period, the data from the 24 h ECG recording was downloaded, displayed and analyzed both visually and using dedicated software (Holtersoft, Novacor S.A., 4 Passage Saint-Antonine, 92508 Rueil-Maimaison, Cedex, France). Types and frequencies of various dysrhthmias were recorded in addition to hourly minimum, mean and maximum heart rates. All ECGs were recorded and analyzed by one operator (AR).

Statistical analyses

The two age groups were compared using one way ANOVA. Hourly mean heart rates over the 24 h recording period were compared for each group using the Scheffe test. The 2 groups were compared with respect to the prevalence of dysrhythmias using the Fisher's exact test. Heart rates are presented as mean (±SD). Significance was assumed at P<0.05.

Results

Good quality ECG recordings were obtained from all 24 ponies.

Heart rate

The mean (±SD) hourly heart rates recorded from groups 1 and 2 over a 24 h period are illustrated in Fig. 2. There was no significant difference (P=0.094) in the mean 24 h heart rates between group 1 (38.77 ± 3.07 beats per min) and group 2 (38.87 ± 3.54 beats per min). In each group, the lowest heart rates were recorded between 00.00 h and 06.00 h (Fig. 2). During this period the heart rate was lower in the ponies in group 2, although this was not statistically significant.

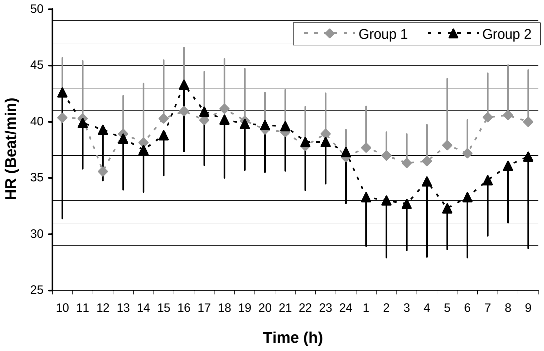

Fig. 2: Mean ± SD of heart rates of two groups of ponies (24 cases) recorded by Holter monitoring

Dysrhythmias

The dysrhythmias detected during analyses of all 24 h ECG recordings included sinus arrhythmia (SA), sinoatrial block (SAB), premature atrial complexes (PAC), premature ventricular complexes (PVC), atrioventricular block (AVB) and ventricular escape beat (VEB).

The dysrhythmias detected in each pony in each group are summarized in Table 1. Of the 3/24 ponies in which no dysrhythmias were detected, 2 were in group 1 and 1 was in group 2. The most common dysrhythmia in both groups was sinus arrhythmia (group 1: 7/14; group 2: 5/10). No premature atrial or ventricular complexes were detected in group 1 and no ventricular escape beats were detected in group 2. There were no significant differences between the 2 groups with respect to any of the following dysrhythmias; sinus arrhythmia (group 1: 7/14; group 2: 5/10), sinoatrial block (group 1: 5/14; group 2: 1/10), atrial premature complex (group 1: 0/14; group 2: 3/10), ventricular premature complex (group 1: 0/14; group 2: 1/10), atrioventricular block (group 1: 6/14; group 2: 4/10) and ventricular escape beats (group 1: 1/14; group 2: 0/10), although the greater prevalence of PACs in group 2 compared with group 1 appeared statistically significant (P=0.059). Group 2 had significantly (P<0.05) more premature complexes than group 1 if PVCs and PACs were considered together.

In many cases, dysrhythmias occurred in a variety of combinations. Second-degree atrioventricular block was found in 10/24 ponies, of which 6 had AVB as a single conduction disturbance, and 3 had AVB in association with atrial premature complexes. Similarly, sinus arrhythmia was detected in 12/24 ponies, of which 4 had SA as a single conduction disturbance, 3 had SA in association with sinoatrial block only, 3 had SA in association with both SAB and AVB and 2 had SA in association with PAC only. Sinoatrial block was detected in 6 ponies and was never present as the only dysrhythmnia. In 3 ponies SAB was associated with SA and in 3 ponies SAB was associated with AVB.

Most of the atrioventricular (AVB) and sinoatrial blocks (SAB) occurred when the heart rate was slow; periods of sinus tachycardia also occurred during the night.

Table 1: Types of cardiac dysrhythmias recorded by Holter monitoring from poines

Group 1 (<15 y.o)		Group 2 (>15 y.o)	
Animal No.	Types of cardiac dysrhythmias	Animal No.	Types of cardiac dysrhythmias
1	VEB	1	SA
2	SA	2	SA, PAC
3	SAB, SA	3	R
4	SAB, SA	4	AVB, PAC
5	SA	5	AVB, SAB, SA
6	AVB	6	PVC
7	AVB	7	AVB
8	AVB, SAB, SA	8	AVB
9	R	9	SA, PAC
10	SAB, SA	10	SA
11	SAB, AVB, SA		
12	R		
13	AVB		
14	AVB		

Discussion

This paper describes for the first time the detection frequency of cardiac dysrhythmias in two age groups of ponies using 24 h EGC recording. In addition to permitting the detection of sustained dysrhythmias, the use of this technique allowed transient or paroxysmal dysrhythmias to be identified, which may otherwise have been missed during routine short duration ECG examination. Additionally, as restraint of the ponies was not required, sympathetic over-riding of vagal tone was minimized. The potential importance of vagal tone on the frequency of detection of certain dysrhythmias was supported by the greater occurrence of sinoatrial and atrioventricular block during periods of relative bradycardia in both groups.

Despite the reported lower incidence of dysrhythmias in ponies compared with horses (Buss *et al*., 1975; Rezakhani, 1978; Machida *et al*., 1992), this study demonstrated that only 3/24 of the studied ponies had a regular heart rhythm without any cardiac irregularities throughout a 24 h period. The remaining 21/24 of the studied ponies demonstrated 6 different types of cardiac dysrhythmias either as a single rhythm irregularity or in association with others. Additionally, and in contrast to previous reports (Rezakhani, 1978), second degree atrioventricular block was relatively common. Reef (1999) also reported an increased frequency of second degree atrioventricular block during 24 h continuous ECG monitoring in horses (44%). This value is similar to that reported in the present study in ponies, but less than that detected when a short resting ECG was recorded (15-18%). The difference in the methods used to record the ECG may explain the increased frequency of second degree atrioventricular block recorded in the present study compared to previous reports in ponies (Rezakhani, 1978).

Interestingly, with the exception of premature atrial complexes (PACs) and premature ventricular complexes (PVCs), all other dysrhythmias were observed in both groups. Although infrequent premature beats in clinically healthy horses may not be indicative of heart disease (Reef, 1989), the previously reported detection of microscopic myocardial lesions in old horses and mules (Marcus and Ross, 1967) may partly explain the detection of these dysrhythmias, exclusively in the older group. As PACs and PVCs were detected in only 4/10 ponies in the older age group, inclusion of a greater number of ponies in such a study may have resulted in a statistically significant difference between age groups with respect to their prevalence.

The lack of a statistical difference in the heart rate in the older ponies is contrary to the findings in other species (Jose and Collison, 1970; Alings and Bouman, 1993). The lack of a statistically significant difference in the heart rates of the two groups between 00.00 h and 06.00 may have been due to the smaller number of ponies in the older group (n = 10). However the lack of a significant difference may have been due to the age range of the ponies studied. Ponies over the age of 15 years were considered elderly based on a previous demographic study of the equine population of northern Britain (Mellor *et al*., 2001). It was found that the equine population is stable up to 15 years of age, after which there was a steady decline in numbers. However in a recent study on the effects of aging and training on maximal heart rate in racehorses, horses aged 6.8 ± 0.4 years were considered to be young, 15.2 ± 0.4 years middle aged and those aged 27 ± 0.2 years old (Betros *et al*., 2002). There was no difference in the maximal heart rate of the young and middle aged groups, however, the old horses had a significantly lower heart rate compared to the young and middle aged horses. Although the median age of the group 2 ponies in the present study was 27.5 years, the age range of the group was from 19 to 33 years. A study of an older group of ponies may have been more representative of an elderly population and may have provided significant data. In the study by Else and Holmes (1971) 53.3% of the horses with atrial fibrillation were over 20 years old.

In summary, this study reported a greater prevalence of cardiac dysrhythmias in ponies than previously reported (Buss *et al*., 1975; Rezakhani, 1978). This greater detection frequency was probably due to the use of 24 h Holter monitoring in non restrained ponies. The prevalence of vagally mediated cardiac dysrhythmias in the ponies used in this study was similar to that previously reported in horses (Reef, 1989, 1999).

Acknowledgements

The authors would like to thank Dr. Shahram Shekarfroush, from the School of Veterinary Medicine of Shiraz University for his assistance in statistical analysis and Mr. Keith Chandler for sourcing the ponies. The financial support of Dr. Rezakhani's study leave was provided by Shiraz University in Iran.

References

Alings, AMW and Bouman, LN (1993). Electrophysiology of the ageing rabbit and cat sinoatrial node: a comparative study. Eur. Heart J., 14: 1278-1288.

Betros, CL; McKeever, KH; Kearns, CF and Malinowski, K (2002). Effects of ageing and training of maximal heart rate and VO2 max. Equine Vet. J., (Suppl.), 34: 100-105.

Bonagura, JD and Reef, VB (2003). Disorders of the cardiovascular system. In: Reed, SM; Bayly, WM and Sellon, DC (Eds.), *Equine internal medicine*. (2nd Edn.), St. Louis, W. B. Saunders Co., P: 433.

Buss, DD; Rawlings, CA and Bisgard, GE (1975). The normal electrocardiogram of the domestic pony. J. Electrocard., 8: 167-172.

Costa, G; Illera, M and Garcia-Sacristan, A (1985). Electrocardiographical values in non-trained horses. Zbl. Vet. Med., 32(A): 196-201.

Else, RW and Holmes, JR (1971). Pathological changes in atrial fibrillation in the horse. Equine Vet. J., 3: 56-64.

Gatti, L and Holmes, JR (1990). ECG recording at rest and during exercise in the horse. Equine Vet. Edu., 2: 28-30.

Hill, G; Atkins, R; Littlejohn, A; Kruger, JM and Bowles, F (1977). Exercise study in the horse: 1. A simple telemetry system for recording exercise ECGs in horses. Equine Vet. J., 9: 72-74.

Hilwig, RW (1977). Cardiac arrhythmias in the horse. J. Am. Vet. Med. Assoc., 170: 153-163.

Holmes, JR (1972). User of on-line computer in a study of cardiac arrhythmia. J. Electrocardiol., 5: 333-339.

Holmes, JR (1980). Cardiac rhythm irregularities in the horse. In Practice. 2: 15-25.

Irvine, CHG (1975). Electrocardiographic anomalies in the racehorse. N. Z. Vet. J., 23: 262-269.

Jones, SA (2006). Ageing to arrhythmias: conundrums of connections in the ageing heart. J. Pharma. Pharmacol., 58: 1571-1576.

Jose, AD and Collison, D (1970). The normal range and determinants of the intrinsic heart rate in man. Cardiovasc. Res., 4: 160-167.

Jose-Cunilleras, E; Young, LE; Newton, JR and Marlin, DJ (2006). Cardiac arrhythmias during and after treadmill exercise in poorly performing Thoroughbred racehorses. 7th International Conference on Equine Exercise Physiology. Equine Vet. J. (Suppl.), 36: 163-170.

Kiryu, K; Machida, N; Kashida, Y; Yoshihara, T; Amada, A and Yamamoto, T (1999). Pathologic and electrocardiographic findings in sudden death in racehorses. J. Vet. Med. Sci., 61: 921-928.

Machida, N; Nakamura, T; Kiryu, K; Haramaki, S and Too, K (1992). Cardiopathological observation on a case of persistent ventricular tachycardia in a pony mare. J. Vet. Med. Sci., 54: 1213-1216.

Marcus, LC and Ross, JN (1967). Microscopic lesions in the hearts of aged horses and mules. Path. Vet., 4: 162-185.

Mellor, DJ; Love, S; Walker, R; Gettinby, G and Reid, SWJ (2001). Sentinel practice-based survey of the management and health of horses in northern Britain. Vet. Rec., 149: 417-423.

Norr, J (1913). Dus electrocardiogram des pferds, science supnahme und farm. Zeitschrift fur Biologie. 61: 197-229.

Raekallio, M (1992). Long term ECG recording with Holter monitoring in clinically healthy horses. Acta Vet. Scand., 33: 71-75.

Reef, VB (1989). Frequency of cardiac arrhythmias and their significance in normal horses. *Proceedings of the 7th American College of Veterinary Internal Medicine Forum*. PP: 506-508.

Reef, VB (1999). Arrhythmias. In: Marr, CM (Ed.), *Cardiology of the horse*. (1st Edn.), London, W. B. Saunders Co., P: 181.

Reef, VB; Marr, CM and Hammett, B (1993). Holter monitoring in the management of atrial fibrillation following conversion. *Proceedings of the 11th American College of Veterinary Internal Medicine Forum*. PP: 610-613.

Rezakhani, A (1978). The electrocardiogram of the Caspian pony. Adv. Anim. Electrocard., 11: 22-25.

Scheffer, CW; Robben, JH and Sloet Van Oldruitenborgh-Oosterbaan, MM (1995). Continous monitoring of ECG in horses at rest and during exercise. Vet. Rec., 137: 371-374.

Vibe-Petersen, G and Nielsen, K (1980). Electrocardiography in the horse. A report of findings in 138 horses. Nord. Vet. Med., 32: 105-121.

Vincen, TL; Newton, JR; Deaton, CM; Franklin, SH; Biddick, T; McKeever, KH; McDonough, P; Young, LE; Hodgson, DR and Marlin, DJ (2006). Retrospective study of predictive variables for maximal heart rate (HRmax) in horses undergoing strenuous treadmill exercise. 7th International Conference on Equine Exercise Physiology. Equine Vet. J., (Suppl.), 36: 146-152.

Yamamoto, K; Yasuda, J and Too, K (1992). Arrhythmias in newborn Thoroughbred foals. Equine Vet. J., 23: 169-173.