Journal of Equine Veterinary Science 42 (2016) 19–24

Contents lists available at ScienceDirect

Journal of Equine Veterinary Science

journal homepage: www.j-evs.com

Original Research

Arrhythmias in Thoroughbreds During and After Treadmill and Racetrack Exercise

Cristobal Navas de Solis*,[1], Christina M. Green, Raymond. H. Sides, Warwick. M. Bayly

Department of Veterinary Clinical Sciences and College of Veterinary Medicine, Washington State University, Pullman, WA

ARTICLE INFO

Article history:
Received 29 September 2015
Received in revised form 16 December 2015
Accepted 16 March 2016
Available online 4 April 2016

Keywords:
Horse
Exercising arrhythmias
Electrocardiogram
Arrhythmogenesis
Sudden cardiac death

ABSTRACT

The objectives of the study were to develop information regarding the frequency of recurrence of exercising arrhythmias and the relationship of arrhythmia development to exercise intensity and type of exercise in Thoroughbred horses. Electrocardiograms (ECGs) were recorded on nine Thoroughbreds during maximal or submaximal exercise on a racetrack (Ra) and treadmill (Tm). The frequency of arrhythmias on a Ra and Tm was compared, and their relationship to exercise intensity (expressed as HR/HRmax [%]) was evaluated. Sixty-five workouts were analyzed: 46 workouts were on a Tm and 19 on a Ra; median number of workouts/horse was four, and the range was 2–14. Exercising arrhythmias were detected in 4/9 horses (12/65 workouts), and there were postexercise arrhythmias in 7/9 horses (19/65 workouts). Arrhythmias were detected at some point in 8/9 horses. For 7/9 horses, the same rhythm result was obtained during exercise in repeated recordings. For 7/9 horses, the postexercise rhythm was variable: postexercise arrhythmias were present in median: 21%; range: 0%–75% of workouts. The presence of arrhythmias was positively related to exercise intensity ($P = .01$; odds ratio = 1.2) and all occurred during workouts at ≥94% of HR/HRmax (%). Arrhythmias during exercise were more frequent on the Ra than on the Tm ($P = .009$). A single ECG did not always display all the arrhythmias detected over several exercise tests. The presence/absence of exercising arrhythmias was more consistent than postexercise arrhythmias. Arrhythmias were more likely to be detected at maximal or near-maximal intensities and during gallops on the Ra. A larger population needs to be studied before more definitive conclusions are drawn.

1. Introduction

Healthy and poorly performing horses can display arrhythmias during exercise and immediately afterward. The frequency of arrhythmias described in the literature varies with the discipline and the characteristics of the study population (healthy vs. poorly performing horses) [1–8]. Arrhythmias during or immediately after exercise are a potential cause of sudden cardiac death [9–11]. However, in many cases, these arrhythmias are inconsequential [1,2,4,6]. The risk that the detection of arrhythmias implies or the limits between acceptable and nonacceptable rhythms are incompletely understood.

The frequency of arrhythmia detection varies between studies. Up to 96% and 76% of exercising electrocardiograms (ECGs) in normal showjumpers [1] and dressage [2] horses, respectively, can be expected to have supraventricular or ventricular premature depolarizations (SVPDs or VPDs) if the warm-up period is included. The occurrence of arrhythmias is less frequent if only peak exercise is considered, and overall, ventricular arrhythmias are less frequent than supraventricular arrhythmias [2–6]. The immediate postexercise period is a vulnerable time for

* Corresponding author at: Cristobal Navas de Solis, Texas Veterinary Medical Center, 4475 TAMU, College Station, TX 77843-4475.
E-mail address: crisnavasdes@gmail.com (C. Navas de Solis).
[1] Cristobal Navas de Solis present address is Texas Veterinary Medical Center, Texas A&M University, 4475 TAMU, College Station, TX, 77,843-4475.

0737-0806/$ – see front matter © 2016 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jevs.2016.03.018

arrhythmogenesis, with arrhythmia development reported in a large percentage of horses likely due to the rapid return of parasympathetic tone [6,7].

To be able to interpret the clinical significance of exercising arrhythmias and to preserve the health of horses and safety of their riders, studies in differing populations of performance horses and about the reproducibility of exercising ECGs are needed and have recently been recommended by a panel of experts [12]. The present study was designed to gain insight into the frequency of recurrence of arrhythmias during and after exercise and the relationship of arrhythmia development to exercise intensity and type of exercise.

2. Materials and Methods

Electrocardiograms were recorded prospectively on nine Thoroughbreds during maximal or submaximal exercise on a racetrack (Ra) and treadmill (Tm). The workouts were part of normal exercise routines of a research group of horses to maintain fitness or part of their preparation for other exercise physiology studies. Only workouts for which the maximal heart rate exceeded 185/min and for which the recording quality was good were considered. Recording quality was considered good when the R-R interval could be followed throughout the recording. The sampling was of convenience, and there was no randomization. During the study period (August 7, 2013–October 10, 2013), horses exercised other times apart from the times when the ECGs were recorded. The number of resting days between exercise tests was variable (median [range], 2 [1–29] days). There were three mares and six geldings of age (median [range]), 11 [4–18] years that were fit to run at maximal speed. All horses had normal general physical examinations including cardiac auscultation. Horses were ridden on a dirt, 0.8 km Ra, and/or exercised on a high-speed Tm. All horses were participating in other exercise physiology studies, and their maximal heart rates (HRmax) had been previously determined. The intensity of the exercise was expressed as HR/HRmax (%) where HR was the maximal heart rate recorded during each exercise test. A modified base-apex lead was used to allow the horse to be ridden with a saddle or exercised on the Tm with a fitted surcingle [1,12–14]. Adhesive ECG electrodes were glued beneath each other near the left side of the withers in front of the saddle, and two electrodes were placed similarly, just to the left of ventral midline, behind the girth or surcingle. An ECG Televet unit (Engel Engineering Service GmbH, Heusenstamm, Germany) was connected to the electrodes and fixed with adhesive tape to the front of the saddle or surcingle as previously described [1]. Electrocardiogram recordings were stored on a Secure Digital card and reviewed using Televet 100 software (Engel Engineering Service GmbH, Heusenstamm, Germany). For the purpose of this study, sinus arrhythmia or block, second degree AV block, or sinus pauses were ignored. Only arrhythmias during exercise tests (excluding warm-up) and during fast heart rate deceleration, while horses were walking and until the heart rate was 100/min, were considered. Rhythm disturbances were classified as SVPDs and VPDs [15].

Supraventricular premature depolarizations were defined as complexes for which the R-R interval decreased >10% in duration from the previous R-R interval and for which there was no change in configuration of the QRS complex. Ventricular premature depolarizations were defined as complexes for which the R-R interval decreased >10% in duration from the previous R-R interval and for which configuration of the QRS complex was obviously abnormal when compared to the previous sinus QRS complex.

The relationship of the presence of arrhythmias with the type of exercise test (Ra or Tm) and their relationship to exercise intensity (expressed as HR/HRmax [%]) was evaluated by logistic regression analysis. The model corrected for the effect of the individual animal by including horse into the model as a repeated effect. The method used was generalized estimating equations as described by Liang and Zeger, and commercial statistical software (SAS 9.2. SAS Institute Inc, 100 SAS Campus Drive, Cary, NC 27513-2414) was used. The binary outcome was presence (or absence) of arrhythmia. Type of exercise test (Ra or Tm) and HR/HRmax (%) was used as explanatory variables (fixed effects). The analysis was performed separately for arrhythmias during exercise and after exercise.

3. Results

Electrocardiograms from 65 workouts were analyzed (Figs. 1–3). Forty-six workouts were on a Tm and 19 on a Ra; median number of workouts/horse was four, and the range of workouts/horse was [2–14]. Recordings of seven exercise tests were not included in the analysis: two due to HR being under 185/min, two due to a poor quality tracing, and three due to problems with data recording. The (mean ± standard deviation) HR/HRmax (%) was 96 ± 4% (range 87%–100%), and the HR was 215 ± 13/min. There was no difference in HR ($P = .06$) or HR/HRmax (%) ($P = .29$) between exercise bouts performed on the TM and the Ra (Table 1). Exercising arrhythmias were detected in 4/9 horses (12/65 workouts), and there were postexercise arrhythmias in 7/9 horses (19/65 workouts). Overall, arrhythmias were detected at some point of the study in 8/9 horses (25/65 workouts). Tables 1 and 2 summarize rhythm results.

The rhythm result during exercise was repeated in all exercise tests in 7/9 horses (Table 2). For 2/9 horses, the rhythm during exercise varied (Table 2). The rhythm result after exercise was repeated in all exercise tests in 2/9 horses. For 7/9 horses, the postexercise rhythm result was variable (Table 2).

Presence of arrhythmias during exercise ($P = .01$; odds ratio = 1.2; confidence interval = 1.1–1.3), but not after exercise, was associated with HR/HRmax (%) and all occurred during workouts at ≥94% of HR/HRmax (%). Exercising on the Ra was associated with a higher frequency ($P = .009$) of arrhythmias during exercise (Table 1) but not after exercise.