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Differences in the electrocardiographic QT interval of various breeds of athletic horses during rest and exercise

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Abstract *Objectives:* Quantitative measurements of cardiac repolarization, defined as the electrocardiographic QT interval, have important diagnostic implications in humans, as irregularities can trigger potentially fatal ventricular tachyarrhythmia. In both humans and horses, cardiac repolarization is influenced to some extent by heart rate, age, body weight (BW), sex, autonomic tone, and environment. In horses, there is substantial inter-breed variation in size and training, and the aims of this study were therefore to determine the best model describing the QT to RR relationship in breeds of various athletic horses and to test for differences in the QT interval.
Animals: Ten Icelandic horses, 10 Arabian horses, 10 Thoroughbreds, 10 Standardbreds, six Coldblood trotters, 10 Warmbloods (dressage) and 10 Warmbloods (show jumping). All horses were geldings.

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Methods: QT intervals were measured from resting to peak exercise level and plotted against RR intervals. Data points were fitted with relevant regression models, and the effect of breed, BW, and estimated exercise intensity was examined.
Results: For all breeds in this study, the QT interval was best described as a function of RR by the piecewise linear regression model. The breed of horse had a significant effect on the model. There was no systematic effect of BW or estimated exercise intensity, but a high inter-horse variability was observed.
Conclusions: The equine QT interval should preferably be corrected for heart rate according to breed. In addition, the results indicate that equine studies of the QT interval must be designed to eliminate the influence of a large inter-horse variation.

Abbreviations

AIC	Aikaike information criteria
BW	body weight
BPM	beats per minute
ECG	electrocardiogram
HR	heart rate
LQTS	long QT syndrome
QT	time interval from Q wave onset to T wave end
QT_c	QT interval corrected for heart rate
RR	time interval from the peak of the R wave to the peak of the following R wave (cardiac cycle length)
R^2	coefficient of determination
w_i	Aikaike weights

Introduction

In human medicine, quantitative measurements of cardiac repolarization, defined as the QT interval on the surface electrocardiogram (ECG), have important diagnostic implications [1]. It has been well described that disturbance of cardiac repolarization can trigger ventricular tachyarrhythmia in the form of polymorphic *torsades de pointes* and lead to sudden cardiac death [2]. The most common disturbance in humans is a delayed repolarization causing a long QT syndrome (LQTS). Inherited mutations or pharmacologic blockers affecting cardiac potassium channels are known to cause LQTS. Congenital LQTS has not been identified in horses, but unexplained sudden cardiac death is reported on a regular basis during high-intensity exercise [3,4], and might be related to occurrence of severe arrhythmias, as in humans [2,5]. Furthermore, several drugs known to induce LQTS in humans are used in equine medicine [6] and may induce severe cardiac side effects. Also pathologic or structural changes of the heart can prolong the QT interval [7]. However, the definition and natural variation in QT duration must be ascertained before it is possible to make an accurate diagnosis of LQTS in horses. Research aiming to develop treatment options for horses with atrial fibrillation necessitates knowledge of the physiological QT duration to assess the impact of antiarrhythmic drug on the repolarization, and to predict possible cardiac side effects [8]. However, the use of the QT interval as an indicator of cardiovascular health has received minimal attention in equine medicine, despite the similarities between the equine and human potassium channels Kv 7.1 and Kv 11.1, responsible for cardiac repolarization [6,9]. These channels could potentially be affected by similar mutations, blockers, or cardiac remodelling with the same consequences. This minimal attention to the QT interval in equine medicine may be explained by the lack of data describing the normal physiologic variation of repolarization time. The QT interval is highly dependent upon heart rate (HR) in both humans and horses, and should be corrected accordingly to allow a comparison at different HRs [10,11]. Furthermore, factors such as age, body weight (BW), sex, autonomic tone, training and psychosocial elements influence the QT interval in both humans and horses to varying degrees [11—21]. Only a small number of human studies have described inter-ethnic differences in the baseline QT interval, the majority of which found minimal variation [22—25]. None of these studies documented the differences in height or lean mass of the ethnic groups included. There are large inter-breed differences in size and lean mass in many species. Therefore, the aim of this study was to determine the best model describing the QT to RR relationship in different breeds of athletic horses of various sizes, and to examine possible