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Correlation of racing performance with fitness parameters after exercise tests on treadmill and on track in Standardbred racehorses

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Summary

Fitness parameters of racehorses were investigated after standardized exercise tests on treadmill and on track, and correlated with race-time. Twenty Standardbred trotters were divided into two groups (A and B) based on the time recorded during five national competitions carried out before the test. Five horses of group A were tested on a treadmill 3.5% slope and 5 horses were tested on a flat sandy track. The same procedure was carried out for group B horses. VLa4 (speed producing a lactate concentration of 4 mmol/L) and VLal (speed at which the mean variation of lactate was 0.2 mmol/L for an increasing velocity of 1 m/s) of group A and B were compared. The data of this investigation confirmed that different test protocols cannot be easily compared. VLa4 and VLal obtained with both tests seem however to be useful parameters to evaluate fitness in trotters.

Keywords: anaerobic threshold, exercise test, race-time, fitness, Standardbred, horse, lactate

Beziehungen zwischen der Rennleistung und Fitnessparametern bei Trab-Rennpferden nach Belastungstests auf dem Laufband und der Rennbahn

In dieser Studie wurden Leistungsparameter von Rennpferden in einem auf dem Laufband und der Rennbahn durchgeführten standardisierten Belastungstest erfaßt und mit den in Rennen gelaufenen Zeiten verglichen. 20 Trab-Rennpferde wurden anhand ihrer bisherigen Rennleistungen in 2 Gruppen – A und B – eingeteilt. Aus jeder Gruppe wurden 5 Pferde auf einem Laufband mit einer Steigung von 3,5% getestet, die anderen 5 auf einer ebenen Sandbahn. Der Laufbandtest bestand aus einer Aufwärmphase im Schritt (15 min, 0% Steigung) gefolgt von 5 Stufen von je 3 Minuten Dauer mit einer einminütigen Pause zwischen den Stufen (3,5% Steigung). Die Laufgeschwindigkeit wurde von Stufe zu Stufe erhöht (3,5 bis 9,5 m/s). Auf der Sandbahn folgten der Aufwärmphase 5 Läufe über eine Distanz von 1.000 Metern, ebenfalls mit einer einminütigen Pause zwischen den Läufen und einer Steigerung der Laufgeschwindigkeit von Lauf zu Lauf (7,7 bis 10,8 m/s). Alle Pferde wurden von demselben Fahrer gelenkt. In den Pausen wurde Blut aus der Vena jugularis externa zur Bestimmung der Laktatkonzentration im Plasma entnommen. Die Latktat-Laufgeschwindigkeits-Beziehung, zur Ermittlung der VLa4 und VLal, wurde mittels einer exponentiellen Gleichung aufgestellt (VLa4 = Geschwindigkeit, die eine Laktatkonzentration von 4 mmol/l Blut hervorruft; VLal = Geschwindigkeit, bei der die Laktatkonzentration um durchschnittlich 0,2 mmol/l Blut variiert, wenn die Laufgeschwindigkeit um 1 m/s gesteigert wird). Die VLa4- und VLa1-Werte beider Gruppen wurden verglichen.
Die Ergebnisse dieser Untersuchung bestätigen, daß der Vergleich von Leistungsparametern, die mit verschiedenen Testprotokollen bestimmt wurden, schwierig ist. Die in den beiden verschiedenen Belastungstests ermittelten VLa4- und VLal-Werte sind anscheinend trotzdem brauchbare Parameter zur Beurteilung des Leistungszustandes von Trabern.

Schlüsselwörter: anaerober Schwelle, Belastungstest, Rennzeit, Fitness, Trab-Rennpferde, Laktat

Introduction

High-speed treadmills are often used to perform standardized exercise tests to evaluate sporting capacity and anaerobic threshold in athletic horses. Treadmills permit measurement of several physiological parameters at selected exercise intensities under controlled environmental conditions which facilitate the comparisons between and within experimental groups. It has been observed that there are great differences between work on track and on treadmill at different slopes (*Persson* 1983, *Thornton* et al. 1987, *Valette* et al. 1992, *Barrey* et al. 1993). For this reason, treadmill and on track results are not easily comparable. Some authors (*Barrey* et al. 1993, *Galloux* et al. 1993) suggested that a treadmill slope of 3.5% could simulate the workload of an incremental test performed by saddle horses running on a track with a rider. VLa4, defined as the speed at which lactic acid concentration reaches 4 mmol/l, and VLal (speed at which the mean variation of lactate was 0.2 mmol/L for an increasing velocity of 1 m/s)

Tab. 1: Lactate kinetic in group A and B horses during the two tests (mean±SE)

	Treadmill			Track		
	speed m/s	group A mmol/l	group B mmol/l	Speed m/s	group A mmol/l	group B mmol/l
1-step	3.5	0.75±0.06	0.88±0.03	7.66±0.13	1.88±0.18	1.99±0.27
2-step	5	1.17±0.16	0.97±0.03	8.29±0.12	1.99±0.13	2.20±0.28
3-step	6.5	1.26±0.13	1.85±0.29	8.97±0.19	2.18±0.16	3.04±0.37
4-step	8	2.61±0.28	3.71±0.54	9.81±0.20	3.20±0.62	5.05±1.51
5-step	9.5	6.31±1.59	8.15±0.70	10.82±0.21	6.80±2.64	8.37±1.94

seem to be useful parameters to evaluate fitness in athletic horses, however there has been no report of relationship between race performance and fitness parameters in trotters. The aim of this study was to evaluate VLa4 and VLal and their correlation with performance by measuring the kinetics of blood lactate during an incremental exercise test on track and on treadmill at 3.5% slope in athletic Standardbred horses.

Materials and methods

Animals

Twenty Standardbred trotters aged 3 to 7 years were divided into two groups (A and B) according to the time recorded during five national competitions carried out during the two months before the test; the last race was performed one week before the experimental trial. Group A (10 horses) showed a mean time in competition of 1'16"30 over 1000 m whereas group B (10 horses) showed a mean time of 1'20"40. The horses were clinically healthy and were training and racing regularly at the time of the evaluation. Five horses within group A were tested on a treadmill 3.5% slope and 5 horses were tested on a flat sandy track. The same procedure was carried out for group B horses. Horses were trained to run comfortably on a high velocity motorized treadmill (Sato Treadmill, Sweden) for five to seven days before performing the exercise test.

Exercise test on treadmill

The treadmill test consisted of a 15 min warm-up period at walk (1.8 m/s) with 0% slope followed by five steps 3 min each at incremental speed (3.5 – 5 – 6.5 – 8 – 9.5 m/sec) with 3.5% slope. Animals were allowed to rest for 1 minute between each step.

Exercise test on track

The standardized test consisted of a 15 min warm-up period followed by five 1000 m runs at incremental speeds of about 7.7, 8.3, 9, 9.8 and 10.8 m/sec. All tests were performed on the same racetrack on fine days when the track was in firm condition. The same driver was used for all tests. The horses' speed for each 1000 m was timed by stop-watch. Animals were allowed to rest for 1 min between each step.

Analysis

Blood samples were taken by jugular venepuncture during the rest periods following each step and collected into sterile no additive silicone-coated Vacutainer®. Right after, 1 ml of samples were placed into tubes containing 0.1 ml of fluoride/EDTA (Boehringer Mannheim) as anticoagulant and then centrifuged. Plasma was stored at –4°C until analysis. Plasma lactate was analyzed by an automatic analyzer (Boehringer Enzymatic Method) within the same day of the trial. The lactate-velocity relationship was described by a curve calculated according to the exponential model Lactate=EXP(A*V+B)+C, where A is a coefficient of curvilinearity and B and C the constants (*Demonceau* 1989, *Valette* et al. 1991). For each horse the values of A, B and C were estimated using a solver software (KaleidaGraph, Abelbeck Software). The velocity at which the mean variation of lactate was 0.2 mmol/l for an increasing velocity of 1 m/s (VLal) and the velocity which increased venous blood lactate concentration to 4 mmol/l (VLa4) were calculated for each horse. The data obtained during track and treadmill tests were statistically analyzed by ANOVA and correlations with race performances were verified (JMP by SAS Institute).

Results

The plasma lactate response after the two tests showed a large individual variability between horses but no statistical difference between treadmill and track test was seen (tab. 1). At the end of the tests the group B showed a tendency to have lactate concentration more elevated versus group A (8.15±0.70 vs 6.31±1.59 mmol/l on treadmill; 8.37±1.94 vs 6.80±2.64 mmol/l on track). As shown in table 2, all fitness parameters calculated with treadmill exercise test were significantly lower than those calculated on track ($p<0.01$). VLa4 and VLal were significantly higher in group A horses (9.11±0.31 and 8.14±0.31 m/sec on treadmill; 10.66±0.30 and 9.87±0.34 m/sec on track) than in group B (8.17±0.26 and 6.96±0.28 m/sec on treadmill; 9.59±0.30 and 8.80±0.25 m/sec on track) ($p<0.05$).

Tab. 2: Fitness parameters in group A and B horses (mean±SE)

		group A	group B	*significance*
Treadmill	VLal	8.14±0.39	6.96±0.28	p<0.05
Track	VLal	9.87±0.34	8.80±0.25	p<0.05
significance		p<0.01	p<0.01	
Treadmill	VLa4	9.11±0.31	8.17±0.26	p<0.05
Track	VLa4	10.66±0.30	9.59±0.30	p<0.05
significance		p<0.01	p<0.01	

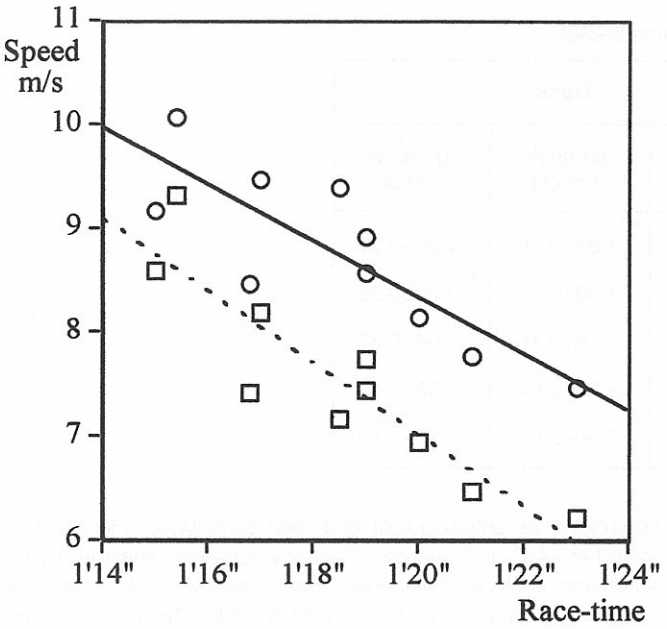

Fig. 1: Scatter plots of race-time with VLal and VLa4 calculate with treadmill test.
□ VLal y=13.922–0.345x R^2=0.82
○ VLa4 y=13.648–0.271x R^2=0.75

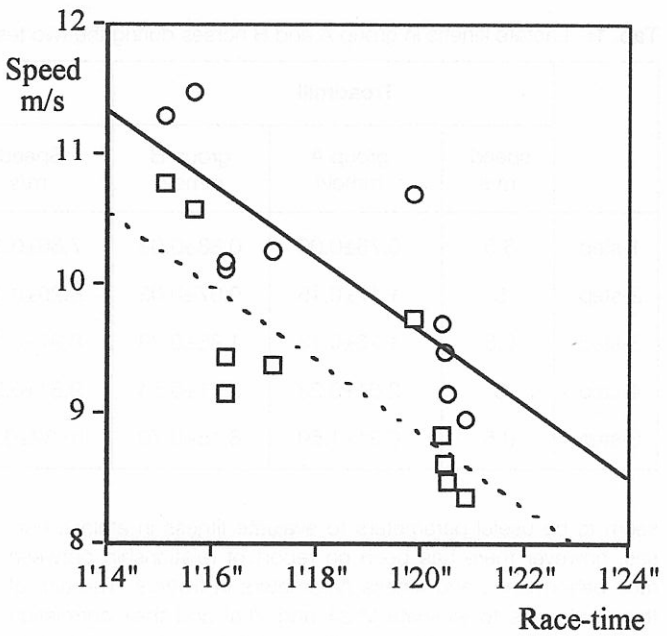

Fig. 2: Scatter plots of race-time with VLal and VLa4 calculate with track test.
□ VLal y=14.537–0.285x R^2=0.64
○ VLa4 y=15.285–0.283x R^2=0.61

VLal and VLa4 showed a significant negative correlation with race-times. The correlation between performance and VLal and VLa4 was stronger for values calculated on treadmill than on track (R^2=0.82 and R^2=0.75 on treadmill vs R^2=0.64 and R^2=0.61 on track) ($p<0.01$). Scatter plots of mean race-time and the fitness parameters that showed a significant correlation are illustrated in figures 1 and 2. The linear regression equations relating race-time to those variables are listed with each graph.

Discussion and conclusions

The data of this investigation confirmed that different test protocols cannot be easily compared; speed, distance, slope of the treadmill and exercise duration have an effect on rise in blood lactate concentration and therefore, on VLa4 and other fitness parameters (*Seehermann* and *Morris* 1990, *Lindner* et al. 1993, *Galloux* et al. 1993, *Sexton* and *Erickson* 1990). Despite lower speeds, our treadmill exercise test seems more strenuous compared with track exercise test suggested by *Wilson* et al. (1983) and used in this study. During treadmill test horses showed an early tiredness and had lower VLa4 and VLal values in comparison with horses on track; probably 3.5% treadmill slope, suggested by *Barrey* et al. (1993) and *Galloux* et al. (1993) for simulating physiological response in horses exercising on a track with a rider, is not suitable for trotters with sulky, but further investigations will be necessary. Both exercise tests seem, however, to be useful to evaluate the curve of lactate accumulation, and fitness parameters obtained with both standardized exercise tests seem to be suitable to evaluate state of training and aerobic capacity in trotters. VLa4 and VLal showed a strong negative correlation with race-times recorded before the tests. The faster horses had the higher VLa4 and VLal values, and it appears reasonable that horses with better performance have a greater aerobic capacity. *Evans* et al. (1993) described associations between Timeform rating and blood lactate response in Thoroughbred horses; in other studies (*Harkins* et al. 1993), a strong correlation with running ability and VLa4 was showed in Thoroughbred. According to the present results and that ones from previous studies (*Wilson* et al. 1983, *Persson* 1983, *Demonceau* et al. 1991, *Harkins* et al. 1993, *Gatta* et al. 1993) VLa4 is a valid parameter to evaluate fitness and performance capacity in Standardbred horses; VLal seems to be interesting too, showing higher correlation with race-time than VLa4. Less variability and stronger correlation in the fitness parameters obtained with treadmill test was noticed; a better speed control during treadmill test probably reduced errors in evaluation. It seems that refinement of treadmill exercise testing offers the best possibility for performance prediction. The indicators discussed seem to provide an useful guide for trainers in assessment of performance.

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