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Conditioning effects in horses of exercise of 5, 15 or 25 minutes' duration at two blood lactate concentrations

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Summary

In a cross-over study design five Thoroughbred horses were exercised 11 times (conditioning period) at their individual $v_{2,5}$ or v_4 for 5, 15 or 25 minutes' duration on a treadmill. The velocities at which horses were galloped ($v_{2,5}$ and v_4) were determined before each conditioning period by an incremental standardized exercise step test (SET) with a step duration of five minutes. The parameters v_4 and v_{200} were used to evaluate conditioning effects. They were always determined before and after a conditioning period. In addition, mean heart rate during exercise and blood lactate concentration after exercise were measured in all horses. Horses did not have any health problems due to the conditioning programmes used. There was no significant effect of any conditioning programme on v_4 and v_{200} or on mean heart rate during exercise. A reduction of the blood lactate concentration after exercise was evident only for exercise at v_4 for 25 minutes.

Keywords: horse, blood lactate, conditioning, duration, v_4, intensity

Einfluß von Training mit Belastungen von 5, 15 oder 25 Minuten Dauer bei zwei Laktatkonzentrationen im Blut auf Pferde

Fünf englische Vollblüter wurden mit sechs verschiedenen Belastungsarten trainiert. Jede der Belastungsarten wurde in randomisierter Folge von jedem Pferd elfmal wiederholt (eine Trainingsperiode = 11 gleiche Belastungen). Die Belastungsdauer betrug 5, 15 oder 25 Minuten, während die Laufgeschwindigkeit der individuellen $v_{2,5}$ oder v_4 entsprach. Die $v_{2,5}$ und v_4 wurden vor und nach jeder Trainingsperiode in einem standardisierten Belastungstest mit Stufen von je 5 Minuten Dauer bestimmt. In den Belastungstests wurde auch die v_{200} bestimmt. Die v_4, die v_{200}, die Herzfrequenz während und die Laktatkonzentration im Blut nach Belastung wurden als Parameter zur Feststellung einer Trainingswirkung verwendet.
Die Pferde waren während des gesamten Versuchs gesund. Keine Trainingsart bewirkte signifikante Veränderungen der untersuchten Parameter. Eine Aunahme bildete das Training bei v_4 über 25 Minuten Dauer. Bei dieser Belastungsart kam es im Verlauf der Trainingsperiode zu einer geringen, aber signifikanten Abnahme der Laktatkonzentration im Blut nach Belastung ($p<0,05$).

Schlüsselwörter: Pferd, Laktat, Blut, Training, Dauer, v_4, Intensität

Introduction

It is common for human athletes to use parameters of the relationship between blood lactate-running speed like v_4 to define exercise intensity in order to give an adequate conditioning stimulus (*Mader* et al. 1976; *Heck* et al. 1985; v_4 = velocity at which a blood lactate concentration of 4 mmol/l is determined mathematically when run under defined conditions). In the running man a blood lactate concentration of 4 mmol/l represents the maximal blood lactate steady state (*Heck* et el. 1985), and it is believed to be the optimal exercise intensity to improve endurance (*Mader* et al. 1976; *Kindermann* et al. 1978).
There are many studies on the effect of conditioning programmes on performance parameters of horses (*Isler* et al. 1982; *Bayly* et al. 1987; *Erickson* et al. 1987; *Rodiek* et al. 1987; *Sloet Oldruitenborgh-Oosterbaan* et al. 1990 b; *Art* and *Lekeux* 1993; *Evans* et al. 1995; among others). However, in most studies, conditioning programmes are not compared (*Milne* et al. 1977; *Bayly* et al. 1987), or exercise parameters such as duration, intensity, frequency are not well defined (*Isler* et al. 1982), more than one parameter is varied (*Rodiek* et al. 1987; *Evans* et al. 1995), or the order of the conditioning programmes is not randomized (*Erickson* et al. 1987; *Sloet Oldruitenborgh-Oosterbaan* et al. 1990 b; *Art* and *Lekeux* 1993). Therefore, in horses the effect of, for example, duration or intensity of exercise has not been investigated yet.
The objective of this study was to investigate which effect conditioning at two blood lactate concentrations for 5, 15 and 25 minutes has on endurance parameters of horses.

Materials and methods

Horses
Five Thoroughbred horses were used. Two horses were 3 years old, and the others were two years old at the beginning of the study (four mares and one gelding), and all were clinically healthy. All the exercise tests and exercise workouts were done on a treadmill at 6% incline. The horses were housed in stables and fed hay and concentrate twice a day. Water was available ad libitum. The mean body weight of the horses was 452 kg ± 21 kg at the beginning of the study and 456 kg ± 30 kg at the end. Horses were acclimated to exercise on the treadmill in the two months before starting the trial. In the first of the two months horses were trained to gallop on the treadmill whilst in the second month they were submitted to exercise at speeds up to 8 m/s at 6% incline

for up to 25 minutes every second day to resemble as much as possible the experimental period thereafter.

Standardized exercise step test (SET)

The SET consisted of several gallop workouts of five minutes' duration each, after a warm up of ten minutes at 1.5 m/s and 4 m/s. Between two consecutive steps there was a resting period of 60 s. The velocity in the first step was 6.0 m/s. Each consecutive step was increased by 0.5 m/s. The test was finished when the horses' blood lactate concentration was above 4 mmol/l. On site blood lactate analysis was done with test-stripes BM-lactate and Accusport® (Boehringer Mannheim GmbH). In that way it was possible to estimate the number of gallop workouts (steps) without underestimating or overestimating lactate concentration. Before the test, but after warm up, and immediately after each step, blood samples were collected from pectoral skin to measure blood lactate concentration. The heart rate was monitored with a heart rate meter attached to the thorax of the horse (Polar Sport Tester). The parameters $v_{2.5}$ and v_4 of blood lactate-running speed relationship were calculated by exponential regression equation (*Galloux* 1991). The parameter v_{200}, which defines the relationship between heart rate and velocity (v_{200} = velocity at which mathematically a heart rate of 200 beats/min is determined when run under defined conditions), was determined by linear regression analysis.

Conditioning programmes and study design

In a cross-over study design with randomized order (Fig. 1), horses were exercised at their individual $v_{2.5}$ or v_4 for 5, 15 or 25 minutes for 11 exercise sessions with one day of rest between two consecutive exercise sessions (six different conditioning programmes). Before each conditioning period of 11 exercise sessions (total length of 22 days = 11 days of exercise and 11 days of rest) horses performed SETs to determine their individual $v_{2.5}$ and v_4 (Fig. 1). The effects of conditioning were evaluated by calculating the difference between v_4 and v_{200} determined with SETs before and after each conditioning period. Additionally the blood lactate concentration after exercise and heart rate during exercise was measured.

↓ ↓ ↓ ↓ ↓

1st conditioning period — 2nd conditioning period — .... — 6th conditioning period

↓ = Standardized exercise test

One conditioning period consisted of 11 exercise sessions with one day of rest between two exercise sessions.

Horse	Conditioning period					
	1st	2nd	3rd	4th	5th	6th
1	15′ at $v_{2.5}$	5′ at v_4	25′ at v_4	15′ at v_4	5′ at $v_{2.5}$	25′ at $v_{2.5}$
2	5′ at $v_{2.5}$	15′ at v_4	15′ at $v_{2.5}$	25′ at $v_{2.5}$	5′ at v_4	25′ at v_4
3	25′ at $v_{2.5}$	5′ at $v_{2.5}$	15′ at v_4	5′ at v_4	25′ at v_4	15′ at $v_{2.5}$
4	15′ at v_4	25′ at $v_{2.5}$	5′ at v_4	25′ at v_4	15′ at $v_{2.5}$	5′ at $v_{2.5}$
5	25′ at v_4	15′ at $v_{2.5}$	25′ at $v_{2.5}$	5′ at $v_{2.5}$	15′ at v_4	5′ at v_4

Fig. 1: Study design and order in which horses were assigned to conditioning with exercise of 5, 15 or 25 minutes' duration at $v_{2.5}$ or v_4.

Blood sample handling and lactate analysis

Blood was collected into a disposable 20 µl capillary pipet after stab-incision of pectoral skin (Blaubrand intramark, Brand Cat. No. 7087181). The 20 µl blood samples were immediately transferred to vials with 200 µl ice-cold 0.6 n perchloric acid. Afterwards, samples were centrifuged at 12000g for 5 minutes, and the supernatant was transferred to another vial and kept stored at –20°C until analysis, normally within two weeks. Analysis was carried out with an EPOS 5060 lactate analyzer using an enzymatic test kit. For the on-site lactate measurement with Accusport® also 20µl of blood was taken from pectoral skin with a capillary tube, and then the blood was blown directly onto the dry chemistry test stripes (Boehringer Mannheim # 1447289). Results of this method were available one minute after starting the analysis.

Statistics

The distribution of the data was normal. The relationship between blood lactate concentration after and mean heart rate during exercise and the number of the exercise session was evaluated by linear regression analysis. Effects of conditioning on v_4 and v_{200}

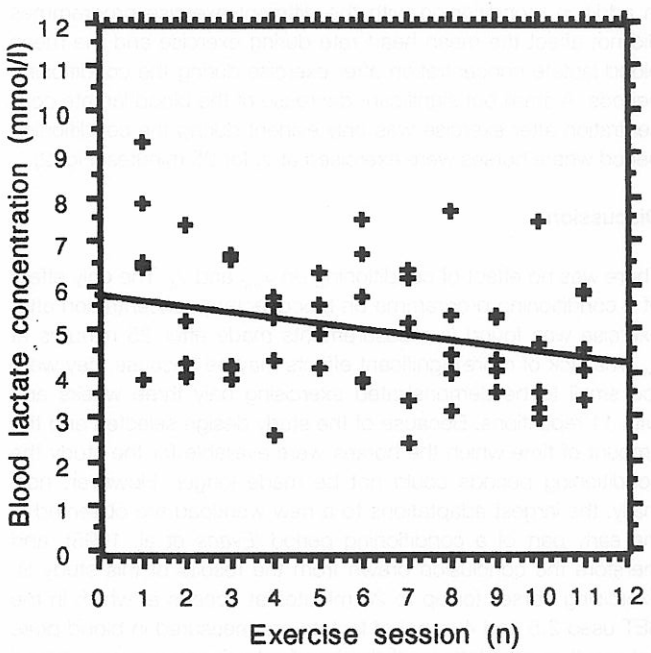

Fig. 2: Development of the blood lactate concentration after exercise of horses during the conditioning period with exercise at v_4 for 25 minutes (five horses; r = 0.28, p < 0.05; SEE of slope = 0.06;
Blood lactate concentration = –0.13* exercise session + 5.85).

Tab. 1: v_4 and v_{200} of horses before and after conditioning programmes (mean ± standard deviation; five horses).

Conditioning programme	v_4 [m/s]		v_{200} [m/s]	
	before	after	before	after
5' at $v_{2.5}$	7.70 ±0.54	7.62 ±0.65	10.01 ±1.39	10.30 ±0.88
15' at $v_{2.5}$	7.95 ±0.39	7.72 ±0.38	10.15 ±1.40	10.58 ±1.52
25' at $v_{2.5}$	7.70 ±0.51	7.63 ±0.28	10.44 ±1.62	10.07 ±0.54
5' at v_4	7.73 ±0.40	7.75 ±0.20	10.52 ±1.92	10.95 ±1.17
15' at v_4	7.99 ±0.65	7.69 ±0.22	10.63 ±1.18	9.95 ±1.18
25' at v_4	7.66 ±0.40	7.94 ±0.43	10.61 ±0.87	10.66 ±1.23

were examined by analysis of variance for repeated measurements. $p<0.05$ was used as the level to denote significant differences.

Results

The mean v_4 and v_{200} of the horses before and after each conditioning period where horses were exercised with the different conditioning programmes are shown in Tab. 1. There was no effect of any conditioning program on v_4 and v_{200} ($p>0.05$).
In addition, conditioning with the different exercise programmes did not affect the mean heart rate during exercise and the mean blood lactate concentration after exercise during the conditioning periods. A small but significant decrease of the blood lactate concentration after exercise was only evident during the conditioning period where horses were exercised at v_4 for 25 minutes (Fig. 2).

Discussion

There was no effect of conditioning on v_{200} and v_4. The only effect of a conditioning programme on blood lactate concentration after exercise was found in measurements made after 25 minutes at v_4. The lack of more significant effects may be because they were too small to be demonstrated exercising only three weeks and with 11 repetitions. Because of the study design selected and the amount of time which the horses were available for the study the conditioning periods could not be made longer. However, normally, the largest adaptations to a new workload are observed in the early part of a conditioning period (*Evans* et al. 1995), and therefore the conclusion drawn from the results of this study is: Exercising horses for up to 25 minutes at speeds at which in the SET used 2.5 and 4 mmol of lactate are measured in blood does not result in adaptations of the heart rate during exercise, blood lactate concentration after exercise, v_4 and v_{200}.
Another explanation for the lack of measurable effects of the conditioning programmes used may be that our horses went through a thorough preparation period before starting the experiment. Measurements done during the pretrial period of heart rate during exercise, blood lactate concentration after exercise, and determination of v_4 showed that the endurance of the horses improved. Therefore, it may be that the lack of measurable effects was due to an already rather high endurance capacity of the horses. However, the goal of conditioning programmes for endurance is to improve endurance. This holds not only for beginners but also for well conditioned and even already competing horses.
Other authors have examined the effect of conditioning horses at a velocity which elicited a defined lactate concentration in blood or plasma during a SET (*Isler* et al. 1982; *Sloet van Oldruitenborgh-Oosterbaan* et al. 1990 a; *Gottlieb-Vedi* et al. 1994). They observed adaptations in the horses similar to those observed when horses were conditioned with other exercise programmes. But in these studies no comparison (*Sloet van Oldruitenborgh-Oosterbaan* et al. 1990 a; *Gottlieb-Vedi* et al. 1994), or well documented comparison (*Isler* et al. 1982) with other conditioning programmes were done. Therefore, based on the results available to date, it can not be stated whether the use of blood lactate measurements as a guide for conditioning horses will help trainers to improve the performance of the horses under their surveillance better than using conventional conditioning programmes.
The practical implication of the results of this study is that it seems unlikely that exercising horses for up to 25 minutes at velocities eliciting a blood lactate concentration of up to 4 mmol/l will improve endurance. It is necessary to examine whether endurance of horses can be improved better with exercise of less than 25 minutes' duration at speeds producing lactate concentrations in blood above 4 mmol/l, or with exercise of more than 25 minutes' duration at velocities eliciting a blood lactate concentration of up to 4 mmol/l (valid for SETs with steps of five minutes' duration).

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