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

Jutta Werkmann, A. Lindner and H.L. Sasse*

Arbeitsgruppe Pferd, Bonn
*Department of Equine Medicine of the Veterinary Faculty, Giessen, Germany

Summary

In a cross-over study design five Thoroughbred horses were exercised 11 times (conditioning period) at their individual \(v_{2,5}\) or \(v_d\) for 5, 15 or 25 minutes’ duration on a treadmill. The velocities at which horses were galloped (\(v_{2,5}\) and \(v_d\)) were determined before each conditioning period by an incremental standardized exercise step test (SET) with a step duration of five minutes. The parameters \(v_{2,5}\) and \(v_{500}\) 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 \(v_{2,5}\) and \(v_{500}\) or on mean heart rate during exercise. A reduction of the blood lactate concentration after exercise was evident only for exercise at \(v_d\) for 25 minutes.

Keywords: horse, blood lactate, conditioning, duration, \(v_d\), intensity

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

Fünf englische Vollblütler wurden mit sechs verschiedenen Belastungssituationen trainiert. Jede der Belastungssituationen wurde in randomisierter Folge von jedem Pferd einmal wiederholt (eine Trainingsperiode = 11 gleiche Belastungen). Die Belastungsduer betrug 5, 15 oder 25 Minuten, während die Laufgeschwindigkeit der individuellen \(v_{2,5}\) oder \(v_d\) entsprach. Die \(v_{2,5}\) und \(v_d\) wurden vor und nach jeder Trainingsperiode in einem standardisierten Belastungstest mit Stufen von je 5 Minuten Dauer bestimmt. In den Belastungstests wurde auch die \(v_{500}\) bestimmt. Die \(v_d\), die \(v_{500}\), die Herzfrequenz während und die Laktatkonzentration im Blut nach Belastung wurden als Parameter zur Feststellung einerTrainingswirkung verwendet.


Schlüsselwörter: Pferd, Laufband, Blut, Training, Dauer, \(v_d\), Intensität

Introduction

It is common for human athletes to use parameters of the relationship between blood lactate-running speed like \(v_d\) to define exercise intensity in order to give an adequate conditioning stimulus (Mader et al. 1976; Heck et al. 1985; \(v_d\) = 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 al. 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 (Iles et al. 1982; Bayly et al. 1987; Erickson et al. 1987; Rodiek et al. 1987; Slot 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 (Iles et al. 1992), 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; Slot 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 ± 30 kg at the end. Horses were acclimatized to exercise on the treadmill in the two months before starting the trial. In the first two months of the 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 (Gailloch 1981). The parameter \( v_{200} \), which defines the relationship between heart rate and velocity (\( v_{200} = \text{velocity at which mathematically a heart rate of 200 beats/min is determined when run under defined conditions} \)), 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 programs). 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.

**Blood sample handling and lactate analysis**

Blood was collected into a disposable 20 \( \mu l \) capillary pipet after stab-incision of pectoral skin (Blaubrand Intramark, Brand Cat. No. 7087181). The 20 \( \mu l \) blood samples were immediately transferred to vials with 200 \( \mu l \) 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 50500 lactate analyzer using an enzymatic test kit. For the on-site lactate measurement with Accusport® also 20\( \mu l \) of blood was taken from pectoral skin with a capillary tube, and then the blood was blown directly onto the dry chemistry test strips (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. 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 \( v_4 \).

**Fig. 2:** Development of the blood lactate concentration after exercise of horses during the conditioning period with exercise at \( v_2 \) for 25 minutes (five horses; \( r = 0.28, p < 0.05 \); SEE of slope = 0.06; Blood lactate concentration = \(-0.13\times \text{exercise session} + 5.89\)).
 Conditioning effects in horses of exercise of 5, 15 or 25 minutes’ duration at two blood lactate concentrations

<table>
<thead>
<tr>
<th>Conditioning programme</th>
<th>( v_4 ) [m/s]</th>
<th>( v_{200} ) [m/s]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>before</td>
<td>after</td>
</tr>
<tr>
<td>5' at ( v_{2.5} )</td>
<td>7.70</td>
<td>±0.54</td>
</tr>
<tr>
<td></td>
<td>10.01</td>
<td>±1.39</td>
</tr>
<tr>
<td>15' at ( v_{2.5} )</td>
<td>7.95</td>
<td>±0.39</td>
</tr>
<tr>
<td></td>
<td>10.15</td>
<td>±1.40</td>
</tr>
<tr>
<td>25' at ( v_{2.5} )</td>
<td>7.70</td>
<td>±0.51</td>
</tr>
<tr>
<td></td>
<td>10.44</td>
<td>±1.62</td>
</tr>
<tr>
<td>5' at ( v_4 )</td>
<td>7.73</td>
<td>±0.51</td>
</tr>
<tr>
<td></td>
<td>10.52</td>
<td>±1.92</td>
</tr>
<tr>
<td>15' at ( v_4 )</td>
<td>7.99</td>
<td>±0.65</td>
</tr>
<tr>
<td></td>
<td>10.63</td>
<td>±1.18</td>
</tr>
<tr>
<td>25' at ( v_4 )</td>
<td>7.66</td>
<td>±0.40</td>
</tr>
<tr>
<td></td>
<td>10.61</td>
<td>±0.87</td>
</tr>
</tbody>
</table>

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 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 (Iser et al. 1982; Sloet van Oldenborgh-Oosterbaan et al. 1990 a; Gottlieb-Vedel 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 Oldenborgh-Oosterbaan et al. 1990 a; Gottlieb-Vedel et al. 1994), or well documented comparison (Iser 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).

References

Acknowledgements
We gratefully acknowledge the assistance of A. Dietrich, S. Marti-Korff and M. Sobotta during the project. The treadmill was kindly provided by the Wissenschaftliche Gesellschaft der Schwarzwald-Tierklinik e.V. (Dr. H. Lauk), and laboratory space by the Institut für Klinische Biokemie der Universität Bonn (Dr. F. Bidlingmaier). This work was possible through the financial support of Verein zur Förderung der Forschung im Pferdesport e.V., Höveller Kraftflutenwerke GmbH, Boehringer Mannheim and Horst Dieter Boyer, who provided the horses.

Jutta Werkmann
A. Lindner
Arbeitsgruppe Pferd
Bonn, Germany

H. H. L. Sasse
Department of Equine Medicine
of the Veterinary Faculty
Giessen, Germany