The Validity of Swimming Training for Two-Year-Old Thoroughbreds

Kazuhiro MISUMI, Hiroshi SAKAMOTO, and Ryosuke SHIMIZU

Laboratory of Veterinary Surgery, Department of Veterinary Medicine, Faculty of Agriculture, Kagoshima University, 1-21-24 Korimoto, Kagoshima 890, Japan

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ABSTRACT. To investigate the validity of swimming training, the following matters were considered: 1) changes in the performance capacity, 2) changes in the constitution and 3) frequency of locomotor diseases. These were evaluated during a training program including both conventional exercise on a track and swimming. In this study, 24 two-year-old thoroughbred horses were studied, and divided into the following three groups: Group A, trained by only running; Group B, trained by running plus a gradual increase in swimming; Group C, trained by running plus constant swimming. As a result of standardized exercise tests, only the intercepts of the 3 regression curves between the speed and the blood lactate concentration in Group B increased significantly as the training progressed. While the growth in height in Groups B and C were greater than in Group A, the increase in girth and weight in Groups B and C were smaller than in Group A. The percentages with locomotor diseases during this experiment in Groups A, B, and C were 62.5%, 12.5% and 25.0%, respectively, and there was a significant difference (p<0.05) between Group A and Group B. As mentioned, it was suggested that a training program including swimming training is seen as being useful for improvement in performance capacity, since it can reduce locomotor diseases in young horses and allow for smooth progress in future training.—Key words: constitution, horse, locomotor disease, performance capacity, swimming.


The acceptance of swimming as a substitute for conventional training and the use of a pool in rehabilitation of race horses following injury is increasing. As concluded by Asheim et al. [1], the advantage of swimming prevents further trauma by concussion while the exercise is continued. Therefore, some veterinary clinicians may wish to recommend the swimming training of horses, but the effect of swimming have yet to be fully explored.

In 2-year-old horses, the increased musculoskeletal stress which occurs as training progresses frequently results in various locomotor diseases, particularly injuries to their extremities. The cause appears to be a poor correspondence of growth or fundamental strength to the exercise at higher training intensity. Swimming is therefore thought to be useful for the harmonious progress of training on the track and for increasing the horses’ strength, since it can provide a sufficient workout without adversely affecting their extremities.

In the present study, young horses were trained in a program which included both running and swimming, the following being examined: (1) Changes in performance capacity, (2) A constitutional changes, and (3) Swimming as a way to prevent injuries.

MATERIALS AND METHODS

Animals: In this study, 24 2-year-old thoroughbred horses (12 males, 12 females, 1.5±0.08 years) were used for the experiments. All were trained to use the harness, and could be driven. They swam 200 m per day, 2 days a week for 2 months before the start of the experiment so as to familiarize them with swimming. After that, they were divided into the following 3 groups consisting of 8 horses (4 males, 4 females), for the 5 month training schedule shown in Table 1. Group A: subjected only to training on a track — trained only by running Group B: subjected to swimming training increased in proportion to the progress of running training — trained by running plus 300 m swimming per day during the first 2 months and 500 m swimming per day during the latter 3 months Group C: subjected to constant swimming training in addition to running training — trained by running plus 300 m swimming per day during 5 months Through the 5 months, running training was performed 6 days a week, and swimming training was carried out 4 days a week. In Group A, the horses were made to swim 200 m per day, 1 day a week during this experiment in order to get them accustomed to swimming.

Before the start of the training, the horses were divided so as to allow for no difference between the athletic ability of Group A and that of Group B. After 2 months’ training, the subjects in Group C were selected from among the horses to continue the same work as Group B, so as not to differ from Group B in their athletic ability.

Measurements: The horses were evaluated from the 3 viewpoints shown below.

1) Evaluation of their performance capacity with a standardized exercise tolerance test: In this study, the horses’ performance was assessed by a standardized swimming exercise test, which appeared to be effective in judging the change in their exercise ability based on our previous study [10]. In this test, horses were forced to swim 100 m 3 times at different speeds. The time spent swimming each 100 m, the maximum heart rate at the time, and blood lactate concentration immediately after each exercise, were measured. The differences in the
Table 1. Training schedule for young horses

<table>
<thead>
<tr>
<th></th>
<th>Running training (6 days/week)</th>
<th>Swimming training Protocol (1) (4 days/week)</th>
<th>Swimming training Protocol (2) (4 days/week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 month</td>
<td>Walk 1,000 m, Trot 1,200 m, Canter 1,200 m</td>
<td>100 m×3/day</td>
<td>100 m×3/day</td>
</tr>
<tr>
<td>1st month</td>
<td>Walk 800 m, Trot 1,800 m, Canter 2,400 m</td>
<td>100 m×3/day</td>
<td>100 m×3/day</td>
</tr>
<tr>
<td>2nd month</td>
<td>Walk 800 m, Trot 1,800 m, Canter 2,400 m, Gallop 400 m</td>
<td>100 m×5/day</td>
<td>100 m×5/day</td>
</tr>
<tr>
<td>3rd month</td>
<td>Walk 800 m, Trot 1,200 m, Canter 3,000 m, Gallop 800 m</td>
<td>100 m×5/day</td>
<td>100 m×5/day</td>
</tr>
<tr>
<td>4th month</td>
<td>Walk 800 m, Trot 1,200 m, Canter 3,000 m, Gallop 1,200 m</td>
<td>100 m×5/day</td>
<td>100 m×5/day</td>
</tr>
<tr>
<td>5th month</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Group A: running training.
Group B: running training+swimming training protocol (1).
Group C: running training+swimming training protocol (2).

correlations of the maximum heart rate and blood lactate concentration to the speed were analyzed statistically. The maximum heart rate was obtained from an electrocardiogram, with an ambulatory ECG recorder (SM-28, FUKUDA Electronic Co., Tokyo, Japan) provided with waterproof electrodes. Blood samples for lactate analysis were taken from the jugular vein within 1 min after each 100 m swim, and immediately deproteinized in chilled 0.8N perchloric acid. The supernatant was removed and assayed for lactate, using an UV method. This exercise test was performed before (Be), 2 (2M), and 4 months (4M) after the start of the training.

2) Physical examination: Throughout the training, the horses' height, girth and weight were measured every month. The differences between the 3 groups in these values from those before training were compared.

3) Investigation on locomotor diseases observed during training: Vulnerability to locomotor diseases during training in each group was investigated, and clinical signs and progress were observed.

Statistics: Between the maximum heart rate, or the blood lactate concentration, and the speed in the standardized exercise test, a regression analysis was used. The change in the correlation with the progression of training was indicated with the significant difference (p<0.05) between either the slopes or the intercepts of the regression line at each time of training — the same as Thornton et al. [15, 16] reported. The values recorded in physical examinations every month were used as the difference from pre-training values, after the mean values before the training were confirmed to be the same for all 3 groups. The data were analyzed by ANOVA. The incidence of locomotor disease in the groups was compared by the χ²-test.

RESULTS

(1) Changes in performance capacity

The data from the standardized exercise tests are shown in Figs. 1 and 2. In all groups the blood lactate concentration correlated positively with speed at any time during the training period (Fig. 1). Statistical analysis of the regression curves showed a significant difference in the intercepts between Be and 2M (p<0.02) in Group A, and between Be (p<0.001), or 2M (p<0.05), and 4M in Group B. There was some difference in the change in the curves in Groups A and B, and the intercept for Group B increased as the training progressed, while that for Group A showed no constant tendency. The alteration from 2 to 4 months of training in Group C resulted in a similar tendency to that in Group B, but was not significant.

In all groups, the maximum heart rate also correlated
Fig. 1. Changes in speed-blood lactate concentration curves in swimming test.

Fig. 2. Changes in speed-maximum heart rate lines in swimming test.
significantly to speed, as did the blood lactate concentration (Fig. 2). There was a significant difference between
2M (p<0.01), or 4M (p<0.02), and Be in the regression lines for Group B. However, in no group was the change in
the relationship constant with training.

(2) Changes in constitution

The measurements in the physical examination before
the training averaged as follows: Group A: height, 155.1±4.05 cm; girth, 172.8±5.28 cm; weight,
432.9±28.44 kg; Group B: height, 153.9±2.30 cm; girth, 174.0±2.39 cm; weight, 441.9±23.00 kg; Group C:
height, 152.5±3.74 cm; girth, 174.0±2.62 cm; weight, 449.0±21.39 kg. Analysis of these pre-training values
showed no significant difference between the 3 groups.

The differences from pre-training values in each
measurement every month are shown in Table 2.

Between A and B: The increase in height in Group B
was greater than in Group A, and there was a significant
difference (p<0.05) in the 5th month of training. The
increase in girth in Group B was smaller than in Group A
from the 3rd month, and the mean value was significantly
different (p<0.05) in the 4th month. The increase in
weight was smaller in Group B than in Group A, and
there were significant differences (the 2nd, 3rd and 5th
month: p<0.05, the 4th month: p<0.01) after the 2nd
month.

Between A and C: The growth in height in Group C
was greater than in Group A, and the mean values were
significantly different (the 3rd month: p<0.05, the 4 and
5th month: p<0.01) than in Group A throughout the
training.

Between B and C: There was no significant difference
between the 2 groups.

(3) Vulnerability to locomotor diseases during the training

Five, one and two horses manifested some locomotor
diseases in Groups A, B and C, respectively. The
incidence of diseases in Groups A, B and C was 62.5, 12.5
and 25.0%, respectively. The percentage in Group A was
significantly higher than in Group B (Fig. 3).

An outline of the clinical signs of various locomotor
diseases observed during this experiment are shown in
Table 3. In Group A, these troubles tended to become
chronic.

Table 2. The differences from pre-training values in each constitutional measurement every month

<table>
<thead>
<tr>
<th>Month</th>
<th>Height (cm)</th>
<th>Girth (cm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>0.9±1.36</td>
<td>2.0±1.31</td>
<td>2.5±2.00</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1.5±1.20</td>
<td>2.5±1.07</td>
<td>3.0±1.69</td>
</tr>
<tr>
<td>3</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2.3±1.16</td>
<td>3.1±0.99</td>
<td>4.1±1.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2.4±1.30</td>
<td>3.9±1.36</td>
<td>4.5±1.31</td>
</tr>
</tbody>
</table>

*: p<0.05, **: p<0.01, ***: p<0.001.
Table 3. Clinical signs in locomotor diseases observed throughout the training period

<table>
<thead>
<tr>
<th>Group</th>
<th>Clinical sign</th>
<th>Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Tendinitis</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Lameness in shoulder</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Lameness in coxa</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>Tendinitis</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>Tendinitis</td>
<td>2</td>
</tr>
</tbody>
</table>

DISCUSSION

It is expected that various locomotor diseases involved in lameness are frequently confronted in young horses during continuing exercise, and result in preventing the progress of training or the development of horses' performance capacity. Until recently, studies on skeletal growth have been conducted from the viewpoint of medical science. The assessment of the radiographic closure of various growth plates was undertaken [8], and skeletal maturity in young horses is now being evaluated by radiographic photodensitometry [3, 9] or ultrasound velocity measurements [3, 7]. On the other hand, although the use of swimming which is said to be effective in preventing these diseases from a clinical viewpoint, is now on the increases, the effects of swimming for horses, particularly the influence of athletic ability, constitution and vulnerability of the diseases, have not been described.

In this study, horses' performance was assessed by a standardized swimming exercise test. This test is thought to be effective in judging the change in their athletic ability, based on our previous study in which the change in performance capacity in swimming was similar to that in running when the adaptation in horses trained by running was evaluated with the change in the correlation between the speed and blood lactate concentration in both the running test and the swimming test [10]. This was also indicated in another study, in which Tan et al. reported that rats trained by running show adaptation in the change in the blood lactate concentration that was induced by a different type of physical stress, swimming [14].

The regression curve for the relationship between the swimming speed and the blood lactate concentration showed significant changes, with a constant tendency only in Group B. This significant increase in the intercept with training in Group B agreed with the change in the standardized treadmill test indicated by Thornton et al. [15]. They reported that the significant increase in the intercept of the curve in response to training expresses the reduced anaerobic energy yield at any given workload [15]. In Group A, the regression curves showed a significant difference between Be and 2M, but there was no constant tendency throughout the training period. In Group C, the intercept in 4M was higher than in 2M, but there was no significant difference between the 2 curves. It was therefore suggested that harmonious progress of training on a track or in a pool resulted in favorable improvement in the horses' aerobic capacity in Group B. As there was no significant difference between the 2 curves in Group C, it was thought to be necessary to increases swimming exercise in proportion to the progress of training on a track, for effective development of their athletic ability.

The regression lines between the swimming speed and the maximum heart rate differed significantly in Group B, but the change was not constant throughout the training. It has often been pointed out that the heart rate induced in submaximal exercise during a standardized exercise test declined during the training, and can be an index of adaptation [5, 6, 11–13]. However, in this investigation, heart rate during swimming was not thought to be a useful index for evaluating athletic ability. This might be because the heart rate during exercise is easily affected by external factors, including mental and environmental stress except for stress induced by exercise.

While the growth in height in Groups B and C tended to be greater than in Group A, the gain in girth and weight in Groups B and C was smaller than in Group A. The change in weight was different in Groups A, B and C, and in Groups B and C was nearly unchanged or showed a tendency to decline while an increase was seen in Group A. It was indicated that the horses' constitution was moderately maintained without becoming overweight in Groups B and C although the horses in all groups grew normally. Åstrand et al. reported that there was no significant change in the weight-height ratio between young female swimmers and women as old as in age [2]. Consequently, these results obtained in this experiment seem to imply that Groups B and C were given more training than Group A, rather than reflecting the immediate effect of swimming training.

The subjects in all groups had some locomotor diseases. The incidence of the diseases in the group trained only by running (Group A; 62.5%) was higher than in the group trained by both running and swimming (Group B; 12.5%, Group C; 25.0%), and there was a significant difference (p<0.05) between Group A and Group B (Fig. 3). All the diseases observed during this investigation were accompanied by lameness preventing the remainder of the schedule from being carried out. In particular, few diseases in the Group A horses were cured completely. Since the diseases in Group A tended to be recurrent, the horses in pain in Group A could therefore not complete the exercise planned in advance. Erickson et al. reported that of the six 2-year-old horses trained for 25 weeks, three showed signs of degenerative joint disease or tendinitis [4]. Since the exercise used in the present study was more intense than in their experiment, these incidences obtained in the present study did not appear to be too high.

As already mentioned, the results suggested that the introduction of swimming into the conventional training protocol used for young horses can decrease vulnerability to locomotor diseases, provide favorable results regarding
training, and is useful for moderate maintenance of their constitution or for efficient improvement of their performance capacity.

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REFERENCES


