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Changes in stride parameters of a horse's jump during the second part of training in the 100-days performance test

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The subject of the present study was the horse's biomechanical response to training during the stationary 100-days performance test for Trakhener stallions. Ten stallions were filmed during the 100-days performance test, in the 62nd and 92nd day of training. Linear jumping stride parameters were measured for take-off and landing distances for each limb separately, as well as the differences between limb placement in pairs at take-off and landing were calculated. Data from the video image analysis were collected using a 25 fr/sec camera and measured by the manual Micro Station program. The parameters were filmed on a spread (oxer) obstacle of the height and width of 1.05 m, jumped three times by each horse. A total number of 60 jumps was analysed. The analysis of variance was performed using Mixed procedure of the SAS program with the random effect of the horse and fixed effects of the trial and successive number of the jump. The effect of training was significant for all take-off parameters and two parameters of front limb at landing. The effect of the successive jump was statistically significant for the landing distance of the hind non-leading limb as well as for distance between hind limbs at landing. The effect of the horse was significant for all the measured parameters. The effect of jumping training for the young horse at an early stage seems to be more important for the take-off than for the landing technique. It is also more significant for front limbs than for hind limbs.

KEY WORDS: jumping parameters / kinematics / stallion / training

Jumping style, as well as the scope of the jump, seem to be the most important elements to be taken into account during the evaluation of jumping predispositions of sport horses. The jumping technique of elite sport horses was investigated in a very detailed manner under laboratory conditions [1, 6, 7]. Absence of biomechanical investigation is observed in the area of training study in field tests, which could be easily applied in the equestrian practice. The effect of 11-months training observed on horses aged 3 years trained in performance centres showed a different horse response in free jumping and jumping with the

rider [4]. A great deal of studies ought to be undertaken on the subject since measuring the effect of training is complicated and could depend on many other environmental conditions. Investigating changes in the linear characteristics of the jumping stride during training in the 100-days performance test is the aim of the presented study. This knowledge should be useful in sport horse breeding during selection procedures in free jumping.

Material and methods

The aim of the present study was the horse's biomechanical response to training during the stationary 100-days performance test for Trakhener stallions. Ten stallions were filmed during the 100-days performance test, in the 62nd and 92nd day of training. The investigated group of horses jumped the same kind of jumping combination consisting of an indicator pole on the ground at a distance of 3.5 m in front of a cross-pole obstacle, then at a distance of 7.1 m – a vertical obstacle 0.8 m high, and then at a distance of 7 m a spread (oxer) obstacle of height and width of 1.05 m. The jumps of all the horses were filmed by Sony DCR-HC46 camera standing in the middle of the riding hall 5 m from the stand, at the height of the highest pole of the obstacle (1.05 m). The measurements were obtained by comparison with a 1m scale placed on the stand of the obstacle.

All horses jumped the obstacle combination three times. The warm-up consisted of exercise in the basic gaits, as well as jumping on lowered heights of the combination (60 cm for 3-4 times). Altogether 60 jumps were filmed and analysed by the Micro Station 95 program.

The following parameters of the jumping stride were measured:

- take-off distance for leading (L) and non-leading (NL) front (F) and hind (H) limbs separately,
- landing distance for leading (L) and non-leading (NL) front (F) and hind (H) limbs separately,
- distance between limbs placement at take-off and landing.

According to the definition of the leading limb by Clayton (1995), each limb in pairs of front and hind limbs that touches the ground first, is the leading limb.

The measurements were analysed by analysis of variance, GLM procedure of the SAS program using the statistical model that included random effect of the horse and fixed effects of the training and successive jump. The effect of the horse may be influenced by the effect of the rider who prepared the horse, although the structure of the observations collected in the official training centre for young stallions does not allow to investigate the effect of the rider. According to the rules for training centres for young stallions the quality of riders is guaranteed to be at the same level. The horses were ridden by four riders that were randomly assigned.

Results and discussion

The effect of the horse was statistically significant for all measured jumping parameters. The effect of the successive jump was statistically significant for the landing distance of the hind non-leading limb, as well as for the distance between the hind limbs at landing.

The investigated differences were observed between the first jumps and the next at landing and between the first jump and the second jump in the distance in hind limbs placement on landing (Table 1).

The effect of the training was statistically significant for all parameters connected with take-off (Table 2). The highest differences were noticed for front limbs placement (30 cm for front leading and 35 cm for front non-leading limb). During the training time the horses learned to jump over the obstacle in a more economical way – from a shorter distance. The take-off distances for every limb were about 20% shorter; this reduction in the leading limbs in both pairs was higher and reached 21% for the front leading and 26% for the hind leading leg. The distances between limbs in pairs was also statistical significant (although at a lower probability value). The differences observed in the distances in pairs of limbs

Table 1 – Tabela 1

The effect of successive number of jump on the parameters

Wpływ kolejnego skoku na analizowane parametry

Parameter Parametr (cm)	First jump Pierwszy skok LSM (SE)	Second jump Drugi skok LSM (SE)	Third jump Trzeci skok LSM (SE)
Taking off FL Odbicie PP	125.07 (1.90)	125.79 (1.90)	125.63 (1.90)
Taking off FNL Odbicie PNP	169.92 (2.43)	172.46 (2.43)	174.54 (2.43)
Taking off HL Odbicie TP	107.73 (1.73)	111.47 (1.73)	108.84 (1.73)
Taking off HNL Odbicie TNP	125.16 (2.06)	128.63 (2.06)	122.90 (2.06)
Distance FL-FNL by taking off Dystans PP-PNP przy odbicu	44.85 (1.76)	46.66 (1.76)	48.91 (1.76)
Distance HL-HNL by taking off Dystans TP-TNP przy odbicu	17.44 (1.97)	17.16 (1.97)	14.06 (1.97)
Landing FL Lądowanie PP	209.19 (3.41)	202.73 (3.31)	205.94 (3.31)
Landing FNL Lądowanie PNP	252.38 (3.81)	242.87 (3.69)	245.91 (3.69)
Landing HL Lądowanie TP	238.51 (3.89)	230.67 (3.77)	237.90 (3.77)
Landing HNL Lądowanie TNP	282.32^{A} (4.26)	264.40^{Ab} (4.13)	275.40^{b} (4.14)
Distance FL-FNL by landing Dystans PP-PNP przy lądowaniu	43.20 (1.36)	40.14 (1.31)	39.98 (1.31)
Distance HL-HNL by landing Dystans TP-TNP przy lądowaniu	43.81^{a} (2.83)	33.73^{a} (2.75)	37.53 (2.75)

FL – front leading; PP – przednia prowadząca
FNL – front non-leading; PNP – przednia nie prowadząca
HL – hind leading; TP – tylna prowadząca
HNL – hind non-leading; TNP – tylna nie prowadząca
a, A – means marked with the same letters differ at $p \leq 0.01$ for capitals and $p \leq 0.05$ for small letters
a, A – średnie oznaczone tymi samymi literami różnią się statystycznie istotnie przy $p \leq 0.01$ dla wielkich liter i $p \leq 0.05$ dla małych liter

Table 2 – Tabela 2

The effect of the training on the parameters

Wpływ treningu na analizowane parametry skoku

Parameter Parametr (cm)	First investigation Badanie pierwsze LSM (SE)	Second investigation Badanie drugie LSM (SE)
Taking of FL Odbicie PP	140.41^{A} (1.55)	110.59^{A} (1.55)
Taking of FNL Odbicie PNP	189.67^{A} (1.98)	154.94^{A} (1.98)
Taking of HL Odbicie TP	125.90^{A} (1.41)	92.79^{A} (1.41)
Taking of HNL Odbicie TNP	139.52^{A} (1.68)	111.61^{A} (1.68)
Distance FL-FNL by taking off Dystans PP-PNP przy odbicu	49.26^{a} (1.44)	44.35^{a} (1.44)
Distance HL-HNL by taking off Dystans TP-TNP przy odbicu	13.62^{a} (1.61)	18.81^{a} (1.61)
Landing FL Lądowanie PP	206.54 (2.76)	205.36 (2.70)
Landing FNL Lądowanie PNP	251.23^{a} (3.08)	242.87^{a} (3.01)
Landing HL Lądowanie TP	237.88 (3.14)	233.51 (3.08)
Landing HNL Lądowanie TNP	275.20 (3.45)	272.91 (3.38)
Distance FL-FNL by landing Dystans PP-PNP przy lądowaniu	44.70^{A} (1.09)	37.51^{A} (1.07)
Distance HL-HNL by landing Dystans TP-TNP przy lądowaniu	37.32 (2.29)	39.40 (2.24)

FL – front leading; PP – przednia prowadząca
FNL – front non-leading; PNP – przednia nie prowadząca
HL – hind leading; TP – tylna prowadząca
HNL – hind non-leading; TNP – tylna nie prowadząca
a, A – means marked with the same letters differ at $p \leq 0.01$ for capitals and $p \leq 0.05$ for small letters
a, A – średnie oznaczone tymi samymi literami różnią się statystycznie istotnie przy $p \leq 0.01$ dla wielkich liter i $p \leq 0.05$ dla małych liter

were not on the same level. After the training time, the front limbs were placed closer to each other. The opposite tendency was observed in the hind pair of limbs. During training horses learned to place their hind limbs at a greater distance. The effect of training did not influence the landing technique in the same way. Only the placement of the front non--leading limb and the distance between the front pair was affected by the training. It was observed that after four weeks of the training the front non-leading limb was placed closer to the obstacle and the distance between the front legs decreased by about 16%. These were the only changes in technique observed during landing.

According to practical show-jumping theories, a shorter jump over the same obstacle requires more scope and effort from the horse to clear it. Young, untrained horses are expected to jump from longer distances. These practical observations were confirmed by earlier investigations of young stallions. The reduction of the take-off distance was obse-

rved also in the second part of the 11-months training of young warm blood stallions [4]. However, changes of distances were smaller, reaching about 4% for take-off. In the cited investigations the distance of landing was not affected by training, either. The effect of training on take-off and landing distances was observed by means of an analysis of jumping technique presented by older sport horses [2]. Reduction of the take-off distance for the leading and non-leading limbs was higher and reached values 16, 18, 21% for front leading, hind leading and hind non-leading limb respectively. The take-off distance for the front non-leading leg was shorter by about 8%. The observed reduction of take-off distances was statistically significant in both reported studies. Such changes were not observed in the other group of sport horses in measurements of take-off distances during longer training, reported four times every 30 days [3]. The differences in this study may be caused by certain differences in the distances in the jumping combination which was observed in warm blood stallions during 100-days performance tests [5].

The effect of training observed as a long lasting process was investigated over a period of four years by Dutch scientists. During their project it was concluded that the effect of training is a short-lasting one [8], although jumping technique allowed to determine the quality of the horse [6, 7]. Knowledge of the biomechanics of the jump, as well as of environmental effects that may affect the evaluation of jumping style by judges was also previously underlined by other authors [6, 7]. The existing information gap concerning the horse's biomechanics ought to be filled, even if studies of training are difficult to conduct because of many environmental effects such as the trainer, the rider, as well as the genetic quality of investigated horses.

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Zmiany parametrów skoku koni podczas drugiej części treningu w 100-dniowej próbie dzielności

Streszczenie

Tematem prezentowanych badań jest odpowiedź biomechaniczna koni podczas stacjonarnej 100-dniowej próby dzielności dla ogierów trakeńskich. Dziesięć ogierów filmowano podczas 100-dniowej próby dzielności w 62. i 93. dniu testu. Liniowe parametry kroku były mierzone dla dystansów odbicia i lądowania dla każdej kończyny oddzielnie, obliczono też różnice pomiędzy ustawieniem kończyn w parach przy odbiciu i lądowaniu. Dane do analizy zdjęć zostały zebrane przy użyciu kamery filmującej 25 stop-klatek na sekundę i zmierzone za pomocą programu Micro Stadion. Parametry skoków były filmowane na przeszkodzie szerokiej (okser), o wysokości i szerokości wynoszącej 1,05 m, pokonywanej przez konie trzykrotnie. Ogółem przeanalizowano 60 skoków. Przeprowadzono analizę wariancji za pomocą programu SAS procedury Mixed, przy uwzględnieniu losowego wpływu konia oraz stałych efektów próby i kolejnego skoku. Wpływ treningu był istotny dla wszystkich parametrów odbicia i dwóch parametrów lądowania kończyn przednich. Wpływ kolejnego skoku był statystycznie istotny dla dystansu lądowania kończyny tylnej nie prowadzącej (TNP), jak i dystansu pomiędzy kończynami tylnymi przy lądowaniu (TP-TNP). Wpływ konia był istotny dla wszystkich mierzonych parametrów. Wpływ treningu skokowego młodych koni na wstępnym etapie wydaje się być ważniejszy dla techniki odbicia niż lądowania. Jest także bardziej istotny dla kończyn przednich niż tylnych.

SŁOWA KLUCZOWE: parametry skokowe / kinematyka / ogier / trening