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The trot characteristics during the first years of dressage training

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Summary

The purpose of this study was to analyse the gait changes in young horses trained for dressage. An accelerometric device fixed at the sternum measured the dorsoventral and longitudinal acceleration of the riding horse. Fourteen young horses (4, 5 and 6 year-olds) trained for dressage were recorded during dressage tests. They were tested during three years. Eight variables were calculated to quantify the rhythm, the regularity, the symmetry, the longitudinal and vertical activities of each figure of dressage test at trot. A variance analysis tested the effect of the first three years of dressage training on the trot variables. It was found that stride frequency decreased significantly ($P<0.05$) after two years of training (1.34 stride/s at the beginning of training and 1.26 strides/s at six year old) and that dorsoventral displacement increased after one year of dressage training before stabilizing at 0.13 m ($P<0.05$). However, the symmetry and the regularity of the trot could be altered at some point during training.

Keywords: dressage, training, young horses, locomotion, kinetic

Charakterisika des Trabes während der drei ersten Jahre der Dressurarbeit

Ziel der Arbeit war, die Veränderungen des Gangbildes beim jungen Pferd, während der ersten Jahre der Dressur zu analysieren. Die Charakterisika des Trabes wurden durch Messen der longitudinalen und dorsoventralen Beschleunigungen des Pferdes mit Hilfe eines am Brustbeinbereich fixierten Beschleunigungssensors ermittelt. Vierzehn junge, im Dressurtraining befindliche Pferde wurden während der Dressuraufgaben gemessen und drei Jahre lang auf dieser Weise beobachtet. Es wurden acht Komponenten berechnet, um die Schrittfrequenz, Regelmäßigkeit des Schrittes, Symmetrie des Schrittes sowie die longitudinalen und dorsoventralen Bewegungen bei jeder Dressuraufgabe quantitativ zu erfassen. Eine Varianzanalyse überprüfte den Effekt der dreijährigen Dressurausbildung auf die Charakteristika des Trabes. Die Ergebnisse zeigen, dass sich die Schrittfrequenz nach den zwei Jahren der Dressurausbildung signifikant ($p<0,05$) veringerte (1,34 Schritte/s zu Beginn des Trainings und 1,26 Schritte/s bei den 6 Jahre alten Pferden). Die dorsoventrale Bewegung nahm nach dem ersten Jahr Dressurarbeit zu, um sich dann bei o,13 m ($p<0,05$) zu stabilisieren.Die Symmetrie und die Regelmäßigkeit des Trabes änderen sich jedoch zu zu besonderen Zeitpunkten der Ausbildung.

Schlüsselwörter: Dressur, Training, Fortbewegung, junges Pferd, Kinetik.

Introduction

It has been assumed that gait changes with training. Drevemo (1980) described an increase of stride length and duration of swing and stride with four standard bred trotters after three years of training. The trot of 12 two and a half year old dutch warmblood was evaluated on a treadmill after 70 days of training (*Back* 1995). Back showed a decrease of stance duration in the hindlimbs in the trained group. Ten months of training decreased the stride length of sixteen male Andalusia horses, young and adult, and increased swing duration (*Cano* 1999). Another protocol (two tests of an increasing intensity work test at velocities of 4, 5, 6, 7 and 8 m/sec, separated by three months) on 20 Andalusia horses of around 4 years of age produced an increase stride frequency and a reduced stride length and vertical stride component (*Munoz* 1999). Conclusions are rarely unanimous because of the diversity of breed, age, type and duration of training and the test.

According to dressage rules, trot is judged by the regularity, elasticity of the steps and by the maintaining of a slow rhythm and a natural balance. The trot is a very important gait as it is the basis of passage, performed by experienced horses. Experienced dressage horses move with more collection. The propulsion of hindlimbs at the trot is more important and the forelimb show an increased braking force (*Clayton* 2001)

In this study, the rider's aim was to reach at least the level St Georges, a middle level test. In order to do that, their program of training began with four year old French saddle horses. It is not possible to dissociate the effect of training and the effect of ageing, the purpose of these study was to quantify the evolution of the fourteen young horses locomotion at trot during the first years of dressage training.

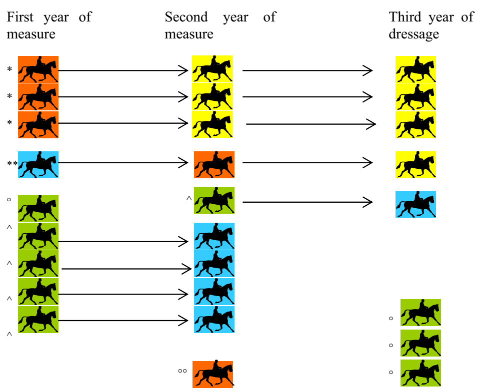
Materials and methods

Horses

Fourteen young French saddle horses were tested during dressage competition with the accelerometric gait analysis system Equimetrix TM[1]. It measured kinetic and temporal stride variables.

- 3 six year-olds (*) and 1 five year-old (**) were tested during three years of training
- 5 four year-olds were tested during two years of training (^)
- 4 four year-olds (°) and 1 six year-old (°°) were tested during one year of training

Fig 1 Diagram illustrating the groups of tested horses: age and duration of participation in the tests during the three years of protocol. Red: 6-year-olds, blue: 5-year-olds, green: 4-year-olds, yellow: 7- and 8-year-olds.
Darstellung der Gruppen untersuchter Pferde: Lebensalter und Dauer der Teilnahme an den Tests während drei Jahre. Rot: 6-Jährige, blau: 5-Jährige, grün: 4-Jährige, gelb: 7- und 8-Jährige



All the horses were not tested during the three years of measure. Some stopped competing (for example, the 4 four-year-olds (^ on figure 1) stopped competing at the end of the second year, 1 four-year-old horse participated only one year (°) in competition. When a horse stopped attending the competition, temporarily or definitively because of injury or insufficient dressage level fixed by the rider, previous records were kept for analysis. Three 4-year-old horses were added during the third year of measure and another during the second year to have homogeneous groups,.

They were daily trained for one hour at least. The type of training alternated between lunge work, riding work inside and outside. They were trained in with the same goal: to reach at least the level of a St Georges test, which is the medium stage of training.

The horses were grouped according to their training history. The 4-year-olds were just beginners. The 5-year-olds had been trained 1 year, the 6-year-olds, 2-year-olds and the 7-year-olds and older horses were grouped in the experienced horses. And the training was adapted to age, according to requirements of dressage rules.

Kinetic characteristics of locomotion at trot were calculated from records of a dressage test in competition. Each horse was tested with his usual rider. The frequency of records depended their participation to dressage tests. The mean of number of records per year of training was:

- 4 records for the first year of training
- 3 records for the second year of training
- 2 records for the third year of training

Gait variables were calculated for each figure at trot on straight line.

Gait analysis

The gait analysis system Equimetrix[1] was composed of an acceleration transducer connected to a small data logger. The transducer was composed of two orthogonal accelerometers, which measured the thorax acceleration continuously along the dorsoventral and longitudinal axes of the horse. It was fixed on the girth of the saddle against the sternum. This location was chosen to capture general information about kinetics of the gait. It was located between the right and left muscles pectoralis ascendens in front of the horse's center of gravity about 60 cm down (*Galloux* and *Barrey* 1997). Acceleration values were positive during the stance phase and negative during the suspension phase. The accelerometers were connected to a small data logger placed in a pocket of the saddle pad. The data acquisition occurred at a rate of 50 Hertz for 10 min, with an antialiasing filter (cut-off frequency 25 Hertz). After recording, data was transferred to a computer for analysis. This method has been described in previous study (*Barrey* et al. 1994, 1995)

Data was treated by signal analysis procedures developed using scientific software (Matlab)[2] to extrapolate the dynamic and temporal variables for each test at trot on straight line

Stride characteristics

Stride Frequency
Stride frequency was defined as the number of strides per unit of time and was also equal to the inverse of stride duration. Stride frequency was usually expressed in strides/s or hertz (Hz) and was measured by detecting the frequency of the major peak of the power spectrum (2xSF) calculated by a Fast Fourier Transform of the dorsoventral acceleration signal.

Stride regularity
The regularity was a sum of the correlation coefficients corresponding to the peaks of the autocorrelation function of the dorsoventral acceleration, measured at a time equal to the half stride and stride duration. It measured the acceleration pattern similarity in the course of time. It was expressed /200).

Stride symmetry
The symmetry was the correlation coefficient corresponding to the peak of the autocorrelation function of the dorsoventral acceleration, measured at the time equal to half stride duration. It measured the acceleration pattern similarly in the course of time.

Dorsoventral displacement
The dorsoventral displacement of the sternum was estimated by a double integration of the dorsoventral acceleration signal. It was expressed in cm.

Dorsoventral activity
The dorsoventral activity was obtained integrating the power spectrum obtained by FFT from the dorsoventral acceleration signal. This variable measured the dorsoventral activity of suspension and loading of the limbs. This variable increases with the amplitude and frequency of movements along each axis. It was expressed in g≈ /Hz

Vector of propulsion
The mean acceleration vector, which produced a propulsive work and the percentage of the stride duration when it was applied. It was expressed in g.

Longitudinal activity
The longitudinal activity was the integral of the module of the power spectrum obtained by FFT from the longitudinal acceleration signal. It measured the amount of deceleration and acceleration along the longitudinal axis of the horse. This variable is related to the breaking and propulsive work.

Vector of braking
The mean deceleration vector, which produced a braking work and the percentage of the stride duration when it was applied. It was expressed in g.

Statistical analysis

All tests at trot on straight line were analysed by group of age. There were four groups : the four-year-olds group, the five-year-olds group, the six-year-olds group and the group of experienced horses (seven-year-olds and older). The four-year-old horses group was composed of 9 horses (5 had been tested four times in the year, 1 had been tested 3 times in the year, 3 had been tested 2 times in the year). The five-year-old horses group was composed of 6 horses (1 had been tested four times in the year, 4 has been tested 3 times in the year, 1 had been tested 2 times in the year). The six-year-old horses group was composed of 5 horses (3 had been tested four times in the year, 2 had been tested 3 times in the year). The group of experienced horses was composed of the three horses who were seven years old the second year of measure, one who was eight years old the third year of measure and one who was seven years old , the third year of measure (seventeen tests). Descriptive statistics were presented. The effect of training (age) was tested for all the variables with a variance analysis and significance set to $p<0.05$.

Results

Means and standard deviations of the eight variables for the four groups, were presented in table 1. Stride frequency and dorsoventral displacement progressed during the first years of dressage training.

The stride frequency decreased particularly after the second year of training. It stabilized from the age of six (Figure 2). The displacement increased significantly as early as the first year of training (Figure 5). The regularity was maintained until they reached the age of six years. It decreased significantly when tests on yuong horses were stopped (Figure 4). The symmetry decreased as early as the first year, it then stabilized until another decrease observed after six year old (Figure 3). The other variable changes (the longitudinal activity) were not significant.

Fig 2 stride frequency (number of stride/s) as a function of horses age
Die Schrittfrequenz in Abhängigkeit vom Alter der Pferde.

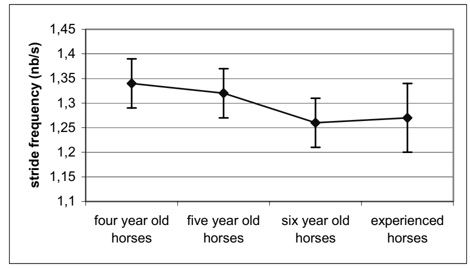


Fig 3 stride symmetry (%) as a function of horses age.
Schrittsymmetrie in Abhängigkeit vom Alter der Pferde.

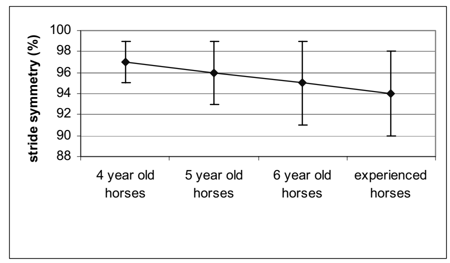


Fig 4 stride regularity (/200) as a function of horses age.
Die Schrittregelmäßigkeit in Abhängigkeit vom Alter der Pferde.

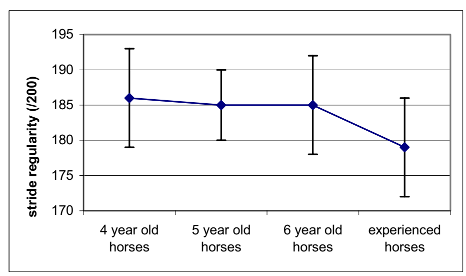
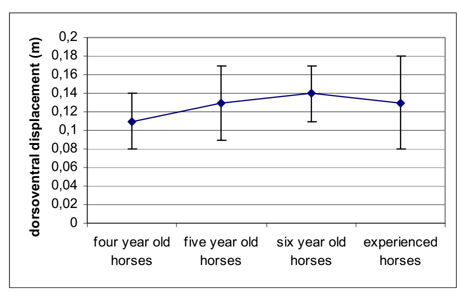


Fig 5 dorsoventral displacement (m) as a function of horses age.
Dorsoventrale Bewegung in Abhängigkeit vom Alter der Pferde.



	four year old horses (9 horses)	five year old horses (6 horses)	six year old horses (5 horses)	experienced horses(4 horses tested 2 years)	P
stride frequency (nb of stride/s)	1,34±0,05 a	1,32±0,05 a	1,26± b	1,27±0,07 b	<0,05
stride symmetry (%)	97±2 a	96±3 b	95±4 b	94±4 c	<0,05
stride regularity (/200)	186±7 a	185±5 a	185±7 a	179±7 b	<0,05
dorsoventral displacement (m)	0,11±0,03 a	0,13±0,04 b	0,14±0,03 b	0,13±0,05 b	<0,05
dorsoventral activity (g²/Hz)	7,8±10	8,3±9,4	8,7±9,8	10,4±11	NS
longitudinal activity (g²/Hz)	1,14±1,57	1,62±2,20	1,55±20	2,10±2,77	NS
vector of propulsion (g)	3,6±4,0 a	5,3±5,1 b	4,3±4,8 ab	3,9±5,4 ab	<0,05
vector of braking (g)	3,2±4,4 a	5,6±6,3 bg	3,8±5,3 ab	4,9±5,1 ab	<0,05

Tab 1 Mean (± sd) trot variables at 4, 5 6 year old an experienced horses. Results with the same letter are not significantly different at $p<0.05$
Mittelwert der Charakteristika im Trab für die jungen Pferde (4-, 5-, 6-jährige Pferde) und für die Pferde mit Erfahrung.

Discussion

It has been assumed that gait was influenced by age and some other factors. Gait particularities depend on breed and range of sports. For example French saddle horses trained for dressage had a higher stride frequency and smaller dorsoventral displacement than German horses trained for dressage (*Barrey* et al. 2002). In this study, horses were French saddle. Considering differences described by *Barrey* et al. (2002), perhaps German horses would not have shown the same evolution at the same time. *Clayton* (1993) compared extended canter of horses trained for dressage and horses trained for racing. At the same speed, the stance durations of race horses were shorter, but the stride frequency was not different. So, it was important to consider the type of training. Four axes of work determined the training of dressage horses : muscle building, general supplying, acceptance of the bridle, learning technique. These axes contributed to develop harmoniously the physique and the ability of the horse.

The main goal for a four year old dressage horse was to work the gait to improve coordination, balance and propulsion. Riders and judges expected a trot with a good regularity and elasticity of the steps and an ability to maintain a slow rhythm. The results showed good similarities with these expectations : a slowing of stride frequency and an amelioration of the dorsoventral displacement. The stride frequency decreased with two years of training. Its final value was reached at the age of six. As early as the first year, the vertical displacement increased with gait collection and then reached a stable value. However, the collection of the gait decreased the stride symmetry and regularity probably because of the rider actions. The symmetry decreased at the beginning of the young horses training and at the beginning of the second cycle of training after six years old. The degradation of these locomotor variables were linked to new training goals at the end of 6 years old competition championship. Horses had to learn more and more collected gait. The other variables were not changed significantly. Their standard deviations were important. The reasons were:

- The values of the table 1 were the mean of the trot variations. Vertical and longitudinal activities differed according to the gait variations (extended, medium and collected). Whereas, according to the dressage rules, stride frequency and regularity should not be modified by gait variations.
- The locomotion was analyzed during three years from tests with increasing difficulties. The ability of young horses was not homogeneous. Some of them stopped training and only 9 of them are actually in competition. They stopped because of lameness or inability to improve.

We could not dissociate the effect of training and the effect of ageing. The weight and muscle strength increased with age and could influenced the locomotion. The training should improve the coordination and the skill of the gaits. This study was carried out during three years of training. However the changes caused by maturation of the body in young horses could not be distinguished from the training effect.

Conclusion

It was concluded that the locomotion of a young dressage horse changed early with the training. According to the dressage rules, the stride frequency decreased and vertical displacement increased significantly. Then, they reached a stable value at six years old. However the symmetry of trot decreased since the first year of dressage training. In experienced horses of seven years old, the new training work for collecting gait affected the stride symmetry and regularity of the trot.

Manufacturers'addresses

[1]Equimetrix™: distributed by Centaure Metrix, 6 Rue Marrier 77300 Fontainebleau, France
[2]The MathWorks Inc, Natick, Massachusetts, USA

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