

KINEMATIC CHARACTERISTICS OF WALK IN THE BARDIGIANO HORSE BREED

CARATTERISTICHE DELLA CINEMATICA DEL PASSO NELLA RAZZA CAVALLO BARDIGIANO

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Key words

Horse, Kinematics, Gaits, Walk

Parole chiave

Cavallo, Cinematica, Andature, Passo

Summary

Selection of horses for inclusion in breed registers and for approval as breeding stock is usually based on the opinion of judges. However qualitative gait analysis based on the judgement of an observer carries all the risks inherent in subjectivity. Video-based kinematic analysis quantifies the features of gait: the output is in the form of temporal (timing), linear (distance) and angular measurements describing the movements of the body segments and joint angles. The data are displayed graphically. In this trial an Italian breed in field conditions was considered, with the aim to find a scientific, objective method for gait evaluation. 14 retro-reflective, hemispheric markers, diameter 2.5 cm, were glued to palpable, anatomically defined locations of the hoof and skin over the left fore- and hind-limbs of 5 Bardigiano mares. The handler kept the lead line loose and the horse performed a relaxed natural walk over a sand surface. Sagittal plane video data were collected by a digital camera (50 Hz) 5 meters far from the horse. Images captured by computer were analysed using SIMI (SIMI Reality Motion Systems GmbH, Germany). In the fore limb were considered the joints: elbow–carpus–fetlock. In the hind limb: stifle–tarsus–fetlock. Parameters observed: stride duration, angular variation, angular velocities of the segments constituting the joint. Mean and standard deviation were calculated. No irregularity in gaits was found. The obtained graphs are a first step in the locomotion characterization of an Italian horse breed. Kinematic video techniques in the biomechanics study can provide practical application for lameness quantification and prevention, as well as shoeing, training and performance evaluation.

Riassunto

La selezione dei cavalli per l'iscrizione ai registri e per l'approvazione come riproduttori dipende generalmente da giudizi basati su valutazioni soggettive. L'ana-

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lisi della cinematica con riprese video esprime quantitativamente le caratteristiche dell'andatura: il risultato consiste in misure temporali (tempo impiegato), lineari (distanza) e angolari che descrivono i movimenti di segmenti ossei e angoli articolari. I dati sono rappresentati graficamente. Le caratteristiche cinematiche della locomozione sono state studiate in diverse razze equine sportive europee e americane. In questa prova di campo preliminare si è considerata una razza italiana, allo scopo di trovare un metodo scientifico e oggettivo per la valutazione delle andature, che rappresentano un problema per i tecnici del L.G. del Cavallo Bardigiano, essendo l'obiettivo di selezione cambiato recentemente da soggetto da lavoro, da tiro, verso il tipo da sella. 14 marker emisferici, riflettenti, di 2,5 cm di diametro sono stati incollati in punti anatomicamente definiti dello zoccolo e della pelle negli arti toracici e pelvici di 5 cavalle Bardigiane di 3 anni. Il conducente senza esercitare trazione faceva procedere il cavallo al passo su una superficie sabbiosa. Le riprese venivano effettuate con una videocamera digitale (50 Hz) a 5 m di distanza. Le immagini processate dal computer erano analizzate con il sistema SIMI (SIMI Reality Motion Systems GmbH, Germany). Articolazioni considerate nell'arto toracico: gomito-carpo-nodello. Nell'arto pelvico: ginocchio-tarso-nodello. Parametri osservati: durata del passo, variazioni e velocità angolari dei segmenti articolari. Per ogni variabile calcolate media e deviazione standard. Nessuna irregolarità è stata riscontrata. I grafici ottenuti sono un primo passo nella caratterizzazione della locomozione di una razza italiana. Le video-tecniche cinematiche possono fornire un mezzo pratico per la quantificazione e prevenzione delle zoppie, per la valutazione delle performance e degli effetti delle ferrature e dell'addestramento.

Introduction

Selection of horses for inclusion in breed registers and for approval as breeding stock is usually based on the opinion of judges. However qualitative gait analysis based on the judgement of an observer carries all the risks inherent in subjectivity (1). Kinematics is the study of changes in the position of the body segments in space during a specified time. The motions are described quantitatively by linear and angular variables that relate time, displacement, velocity and acceleration (2). Video-based kinematic analysis quantifies the features of gait: the output is in the form of temporal (timing), linear (distance) and angular measurements describing the movements of the body segments and joint angles. The data are displayed as graphs and numbers. Kinematic characteristics of locomotion and jumping in several horse breeds have been studied (3, 4, 5). In this preliminary trial an Italian breed in field conditions was considered, with the aim to find a scientific, objective method for gait evaluation during the performance test of the breeding stock. Gaits represent a challenge for the Bardigiano Stud Book technicians, because the breed selection goal changed recently, in order to obtain a lighter saddle horse from the ancient, work and draft type (6). Comfortable gaits are a main necessity in a breed destined to equestrian tourism. The trial will be continued on stallions and taking in account trot as well.

Material and methods

5 Bardigiano mares, 3 years of age, free of any clinical sign of lameness, at the same level of training were considered. Conformation of the horses was in line with standard pattern of the breed: height at withers comprised between 140 and 145 cm, body weight around 450 kg.

14 retro-reflective, hemispheric markers, 2.5 cm of diameter, were glued to palpable, anatomically defined locations (7) of the hoof and skin over the left fore- and hind-limbs of 5 Bardigiano mares. The horses adapted well to the operations and showed no problems with the markers and lights. The handler kept the lead line loose and the horse performed a relaxed natural walk over a sand surface, normally used for schooling and training. Vertical plane video data were collected by a digital camera (50 Hz) 5 meters far from the horse, from the left side. Images captured by computer were analysed using SIMI (SIMI Reality Motion Systems GmbH, Germany). Before each recording the system was calibrated with a calibration frame of known dimension (1, 8). In the fore left limb were considered the joints: elbow–carpus–fetlock. In the left hind limb: stifle–tarsus–fetlock. The following parameters were observed: stride duration, angular variation, angular velocities of the segments constituting the joint. Mean and standard deviation were calculated for all variables by the SIMI System.

Results and discussion

The output are several graphs representing waves, showing the cycles of limb motion. On the abscissae axis the times of execution of the movement and on the ordinate axis the angular variations are reported. The duration of each cycle was standardized to 100 time frame (i.e. percentage of motion cycle).

The waves have been cut into different phases, each corresponding to a single stride, starting and ending at the moment of maximal flexion (9). The walk is a 4 beats gait with large overlap times between stance phases of the limbs and no period of suspension. It is the slowest equine gait but probably one of the more complex gaits because of the variability in the overlap and lag time between limbs (1). The stride is defined as a full cycle of limb motion, including a stance phase when the limb is in contact with the ground and a swing phase when the limb is not in contact with the ground (2, 10) (Fig.1, 2). In this two-dimensional study the angular data are reported as flexion and extension in the sagittal plane (1). In fig.1 the mean of the angular variations of the joints of the fore left limb are shown, while in fig. 2 the mean of the angular variations of the joints of the hind left limb are shown. The lines have a rounded shape, which highlights the fluidity of the movements, comprised between 73° and 160° during flexion and 125° and 220° during extension in the fore limb, and between 108° and 143° during flexion and between 141° and 202° during extension in the hind limb. The angle values of the limbs in maximum extension and maximum flexion are shown in table 1.

No sharp peak appears when walk is considered, as expected, due to the fact that it is a symmetric and slow gait. The characteristics of locomotion in the 5 mares appeared very similar. No irregularity in gait was found.

In this study the horse was led on a sand surface, while most Authors consider gaits on a treadmill (11). It was demonstrated that treadmill provides an excellent means of controlling the regularity of gaits, because the velocity and slope of the treadmill belt are entirely fixed by the operator. The horse adapts rapidly at trot, and stride measurements can be undertaken beginning at the third session. For the walk, many stride parameters are not stable even after the ninth training session (2). Therefore, in present trial it was decided to lead the horse on a sand surface, normally used in training, in accordance with other studies considering walk (4, 12). This trial is a first attempt to prepare an objective method for gait evaluation in an Italian horse breed.

Tab. 1: Angular variation and standard deviation in max. and min. points of limbs flexion and extension

	Max Flex	S.D. Flex	Max Exten	S.D. Ext
Hind Fetlock	143°	3.64	202°	3.03
Tarsus	128°	4.93	154°	1.41
Stifle	108°	2.43	141°	1.50
Fore Fetlock	160°	1.88	220°	3.57
Carpus	108°	4.11	170°	0.37
Elbow	73°	4.29	125°	1.12

Fig. 1: mean of angular variations in the fore limb

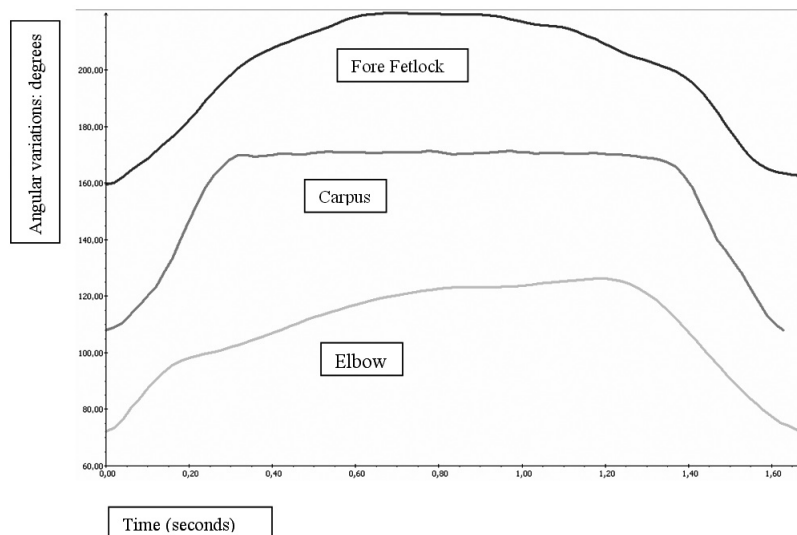
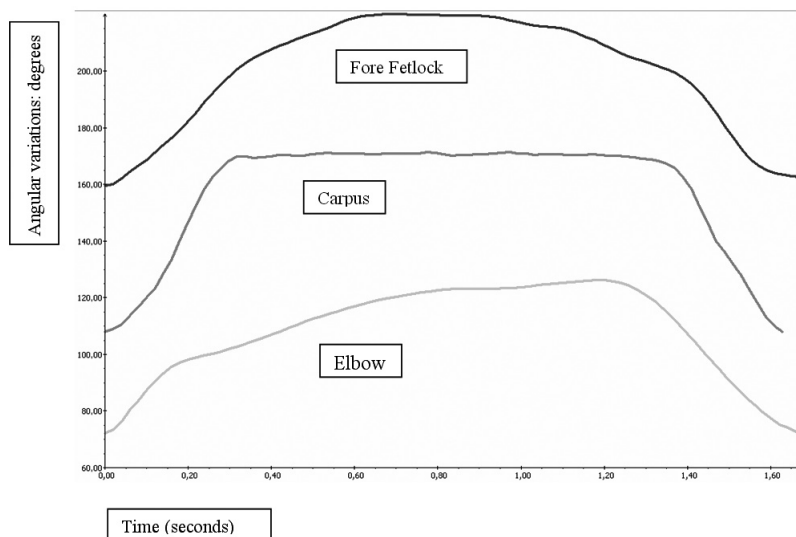


Fig. 2: mean of angular variations in the hind limb



Conclusions

The great improvement in image analysis technology makes it quite easy to apply kinematic techniques in experimental facilities, but the new findings should be extended to the horse industry, because the number of concrete applications available for all the people involved in horse breeding, training, riding and veterinarians is still too limited compared to the amount of research that has been carried out.

This trial is a first step to contribute to prepare applications that can be used in field conditions. The graphs showed no irregularity in walk and very similar characteristics of locomotion in the 5 mares. The obtained data (angle values, wave shapes etc.) can be a reference for further studies and comparisons.

Kinematic techniques in the biomechanics study can provide practical application for lameness quantification and prevention, as well as shoeing, training and performance evaluation.

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