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Original Research

Effects of Rider Experience Level on Horse Kinematics and Behavior

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ABSTRACT

There is little information on behavioral and physical effects of lesson horses being used multiple times a day or ridden by riders of varying levels of skill, leaving lesson program managers with limited information to support horse management and welfare decisions. This study used video analysis to evaluate whether horses exhibited different limb kinematics or patterns of behavior under riders with differing levels of experience, factors that could impact physical effort by the horse. Riders (n = 8) were sorted by skill level (four beginner and four advanced), and horses (n = 8) were sorted by sensitivity level (four reactive and four nonreactive). Then pairs of horses (one reactive and one nonreactive in each pair) and pairs of riders (one beginner and advanced in each pair) were created. The pairs were then used in a repeated 2 × 2 Latin square design. Data were collected at the posting trot, using an English saddle, during the stance phase of single fore and hind footfalls. Multivariate analysis of variance of the kinematic variables revealed no overall trends across the kinematic variables, with only a small number of joints showing near-significant effects. Behaviors were quantified based on a study-specific ethogram and willingness scale, but no differences related to rider skill level or horse sensitivity were identified. Although our data suggest no differences in horse kinematics or behavior between beginner and advanced rider groups of horses ridden at the trot, further trials would be required to test for effects during other portions of the stride cycle, other gaits, or longer durations of locomotion.

1. Introduction

Riding lesson programs are an important component of the equine industry, allowing many people to experience horseback riding affordably, without the responsibility of owning their own horse. Under a high demand for lessons, facilities can be faced with management decisions that could require their lesson horses to work multiple times per day and with riders having varying levels of skill. There is little information regarding the welfare of horses under such lesson program conditions. The purpose of this study was to examine the effects of rider level, beginner versus advanced, on horse behavior and gait kinematics at the trot.

Horses may exhibit certain behaviors that show they are uncomfortable (either mentally or physically) when ridden, such as bucking, rearing, chomping the bit, or head slinging. Multiple studies have examined behavioral patterns related to signs of stress, such as cortisol levels and heart rate [1–3]. In lesson horses, riding behaviors develop in response to the inexperienced riders that ride them. Anecdotally, horses may develop a head flip from pulling on the reins or become slow to move up in gait in response to leg pressure from an unbalanced rider creating unbalance in the horse. However, quantified information about how a rider's level affects the behavior of horses during riding is limited.

Instructors may be able to observe different behaviors in horses ridden by riders with different levels of experience, but how such differences might impact the function and mechanical demands placed on horses is less clear. Previous studies have shown that riders create different forces on the horse's body just by weight and balance changes [4–8]. It has also been seen that horses may alter their gait in response to different riders, with footfall synchrony becoming disrupted under a beginning rider compared to an advanced rider. Riders may influence the

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impulsion and carriage of the horse, with a “well-ridden” horse thought to exhibit greater self-carriage with ease to its gait. Beginner riders are learning balance and the basics of holding their legs and hands correctly to communicate with a horse, and they tend to not have the ability to help the horse position its body to move efficiently and fluidly. Despite such observations, their potential impact on the motion of horse limb joints under periods of weight bearing has not been evaluated. Such differences in kinematics could affect how locomotor forces place the limbs under load, placing horses under different demands and exposing them to different risks in response to riders with different experience levels.

Several studies have shown that there are quantifiable differences in the movements of beginner and advanced riders [9–13]. Measurements of rider joint angles during walks, posting trots, sitting trots, and canters have shown that beginner riders consistently have a more “closed,” or acute, hip angle. The larger hip angle of the advanced rider may be correlated to the lower leg sitting more directly underneath the trunk of the rider, thus creating a more “vertical” position [9–11]. In other studies, advanced riders tended to have less forward pitch of their trunk throughout all gaits, meaning that they tended to have consistently wider hip angles and an upright upper body [9,12]. Beginner riders tend to have greater variations in trunk pitch, contributing to decreased stability in their seat. Advanced riders seem to more closely match the motion pattern of the horse they are riding compared to beginner riders by adjusting the tilt of their pelvis to maintain stability in the saddle [9,12,13]. The presence of such differences between beginner and advanced riders suggests the potential for differences in the kinematics of horses as well.

This study was designed to test two hypotheses. First, we hypothesized that lesson horses would demonstrate differences in limb kinematics when ridden by beginning versus advanced riders. Our specific aim was to focus on the midstance phase of the trotting gait when the limb would be expected to experience high loads that could be impacted by limb position. Such differences could exacerbate potential “wear and tear” on horses over time. Second, we hypothesized that the horses would exhibit different behaviors when ridden by beginning versus advanced riders. The specific goal was to evaluate typical behaviors such as those that demonstrate evading cues, irritation, or anxiety in response to different rider levels.

2. Materials and Methods

Eight female riders ($n = 8$), ranging in age from 15 to 24 years, were sorted by skill level into four beginner and four advanced rider groups using a survey that determined years of experience and riding competency and through consultation with a professional riding instructor. Four pairs of riders were then created (one beginner and one advanced in each pair). Rider's height, weight, and limb segment length measurements were used in the pairing. Eight horses (2 mares, 6 geldings), ranging in age from 10 to 20 years, were sorted by sensitivity level to rider, designating four horses as reactive and four as nonreactive. Sensitivity level of horses was determined by a professional instructor, who was familiar with all of the horses through their use in lesson programs on a regular basis. All horses were of similar fitness level and were in light to moderate use during the time of the study. Four pairs of horses were then created (one reactive and one nonreactive in each pair). Horses' breed and conformation were also used in the pairing. Horse and rider pairs were then randomly combined and blocked into a repeated 2×2 Latin square design.

Horses and riders had 2.54-cm circular markers placed on limb joints for kinematic measurements. Markers were placed on the lateral side of the horses' left fore and hind limb joints at easily palpable anatomical locations [14]. Rider angles of interest were the elbow, hip, and knee joints. Horse angles of interest included the fore and rear fetlocks, knee, elbow, stifle, and hock (see Results—Table 3). Two research assistants were trained by the principal investigator to insure proper placement on each joint.

A straight path (15.24 m) was designated and marked in the riding arena to collect video from trials in which horses trotted under saddle. A digital video camera (GoPro Hero3+, recording at 120 frames per second) was set perpendicular to the path, 9 m from the path of horse travel, and half way down its length (7.62 m). Horses were outfitted with a close contact English saddle. Riders were asked to begin a posting trotting at the first marker and then walk at the second marker (in a straight path along the rail of the arena—separated by 15.24 m). Recording began at the first marker and stopped once the horse passed the second marker. This provided a field of view that zoomed in on two sequential footfalls. These procedures were repeated 5 times for each horse/rider pair.

To calculate limb kinematics from the videos, the positions of joint markers were digitized using the MATLAB (Math Works Inc., Natick, MA) routine DLTdv3 [15] and MATLAB software. Markers on each joint were identified using MATLAB to create coordinates. These coordinate points were used to specify vectors representing limb segments. The angle (ang) between two limb segments (A and B) was then calculated using the standard equation [16]:

$$\cos(ang) = [(A \bullet B)/(vlengthA) \times (vlengthB)]$$

Where ($A \bullet B$) is the dot product of the vectors, and vlengthA and vlengthB are the lengths of vectors A and B, respectively. All joint angles were a single value collected at one moment in the midstance phase. Stride length was calculated from the tip of toe in the midstance phase to the tip of toe in the subsequent midstance phase. A 1-m calibration ruler was placed on the horse's track path to evaluate stride lengths from the videos.

Using the same video footage that was collected for the kinematic analysis of the horse limbs, riders in these trials were evaluated to confirm differences between the beginner and advanced groups. The angles of the elbow, hip, and knee of each rider during each trial were calculated using the same methods applied to measurements of joints for the horses.

Behavioral data were collected using a video camera (Sony DCR-SX63) filming at 30 frames per second. This camera was set at a wide view of the whole arena and recorded the entirety of each riding trial. A study-specific ethogram of riding behaviors (Table 1) and a riding willingness scale (Table 2) were created based on previously published data [1,3]. Each video was evaluated in triplicate by the same observers using the willingness scale, and

Table 1
Study-specific ethogram: descriptions for riding behaviors in horses.

Behavior	Description
Head toss	Abrupt rotating or tossing of the head
Ear pinning	Ears pressed firmly back against head and neck
Head turning	Movement of the head and neck without cue from rider
Head shaking	Repeated movement of head
Tail swishing	Exaggerated movement of the tail; may be more like wringing
Bit chomping	Mouth and tongue manipulation of the bit without aids from rider
Defecation	Expulsion of feces