KINEMATIC ANALYSIS OF THE SLIDING STOP IN WESTERN RIDING AT THE MALLORCA WESTERN REINING TROPHY 2006

Maren Fröger and Christian Peham

Movement Science Group, Department for companion animals and horses, University of Veterinary Medicine, Vienna, Austria

The purpose of this study was to show the acceleration acting during the sliding stop. As data source we used a DVD of 10 finalists of the Mallorca Western Festivals 2006 (reining competition). These videos were analysed using the SIMI-Motion software. Additionally to the defined location on the horse and rider the reference points on the horse (saddle pad) and on the panel fence (advertising board) were digitised. With the help of the reference point the coordinates were determined and the acceleration was calculated. The maximum acceleration of the sliding stop in the running direction was mean=37.92 m/s² (SD=9.47). The vertical acceleration of the sliding stop at this time was mean=8.50 m/s² (SD=6.26).With an expected mass of horse and rider between 500 to 600 Kg, this acceleration will lead to a load between 11.6 KN and 37.6 KN. The conclusion is that the acting load during the sliding stop is comparable to load on the extremity during a gallop race. The question remains what are the effects of the sliding to the lower hind extremities of the horse and does it lead to injuries?

KEY WORDS: Sliding stop, western riding, acceleration, load, video analysis.

INTRODUCTION: Reining is a western riding competition for horses where the riders guide the horses through a precise pattern of circles, spins, and stops. All work is done at the lope and gallop; the fastest of the horse gaits. Sliding Stop: the horse goes from a gallop immediately to a complete halt, planting its hind feet in the footing and allowing its hind feet to slide several meters, while continuing to let its front feet "walk" forward. The back should be raised upward and hindquarters come well underneath (FEI, 2009). See figure 1.

Figure 1: Sliding stop during reining competition (Mallorca Western Reining Trophy 2006).

It is obvious, that the load during the sliding stop on the horse and on the rider is enormous. Especially to the horses' hind legs, therefore it is of importance to know the load to protect the hoofs with suitable horseshoes (skid boots, sliding plates). The aim of our study was to show the stress, expressed by acceleration (deceleration), acting in the centre of mass (Horse and rider), when performing a sliding stop.

METHODS:

Horses and Riders: 7 horses were Quarter horses and 3 Paint horses. The mean age of the horses was 6.8 years (SD 1.3). Riders and horses were top performers. Included were European champion, Futurity-champion, Derby-champion and two riders earned more than 1 Million US$ prize-money.

Data Collection: Videos of a DVD of the Mallorca Western Reining Trophy 2006 were the base material. Type of the camera is unknown to the authors. 10 finalists of the reining competition were analysed for this investigation. For obtaining a two-dimensional motion analysis, the recorded videos were imported into the motion analysis program SIMI-Motion. The next step was to calibrate each frame with the help of reference points. The calibration procedure was two folded. We used 2 reference points on the horse (saddle pad) to determine the effect of zooming (local coordinate system). The length of the saddle pad is known, 91 cm in all horses. Additionally 5 reference points on the panel fence were necessary to complete the calibration (Global Coordinate System). With help of the reference points the coordinates were calculated. The sampling rate of the videos was 50 frames per second.
The starting frame at digitising was the moment when the horse prepares for the sliding stop; i. e. the horse's hind quarters were under the horse's body in stretched position, ready to slide. The last frame was the moment when the horse stopped (Figure 2).

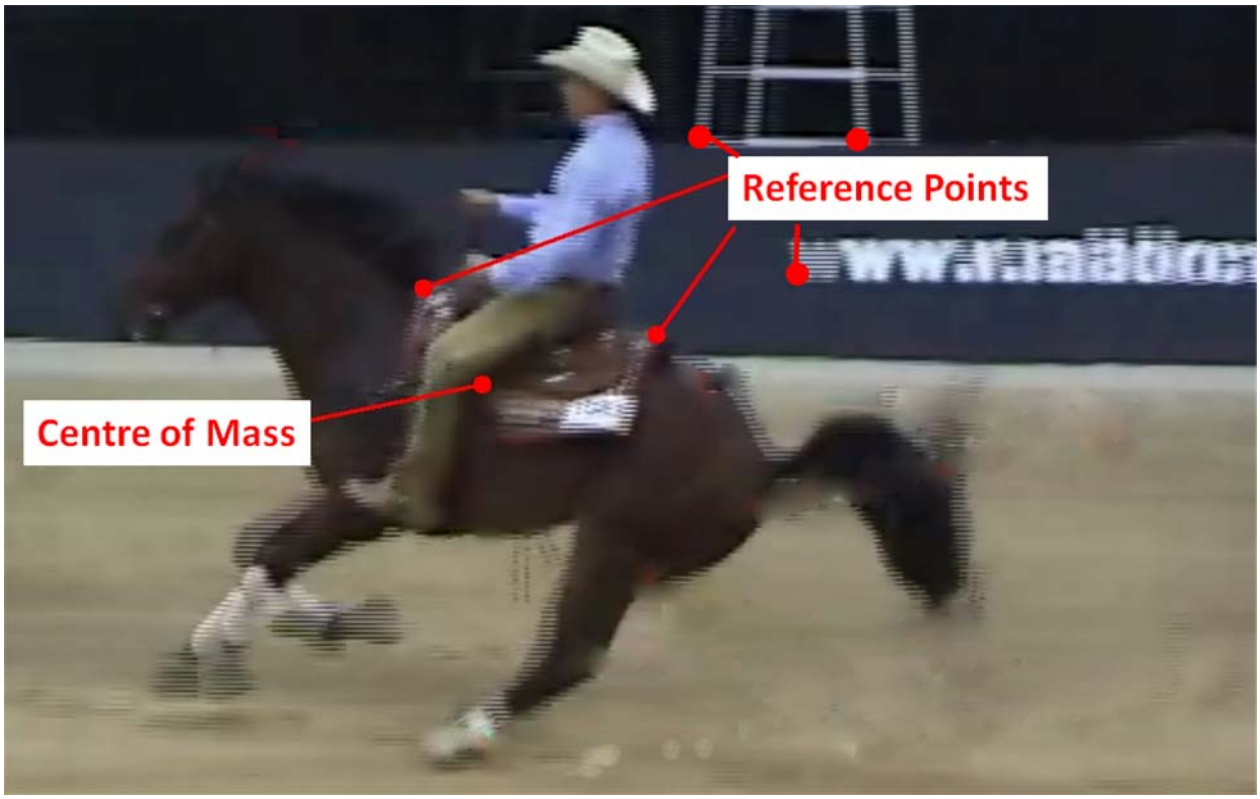

Figure 2 shows digitized points; the reference points and the estimated centre of mass

Data Processing: The data were smoothed using a moving average. Then the accelerations were calculated by differentiating the smoothed data twice. The error induced by the smoothing can be expressed through the goodness of fit (r^2). For all horses the goodness of fit was higher than 0.9 ($r^2 > 0.9$). The minimum acceleration was used to determine the forces (see figure 3). The Centre of mass was estimated under rider in the middle of the saddle pad (Buchner et al., 2000). The resulting forces have been obtained on the basis of mass of horses and riders between 500 kg and 700 kg.

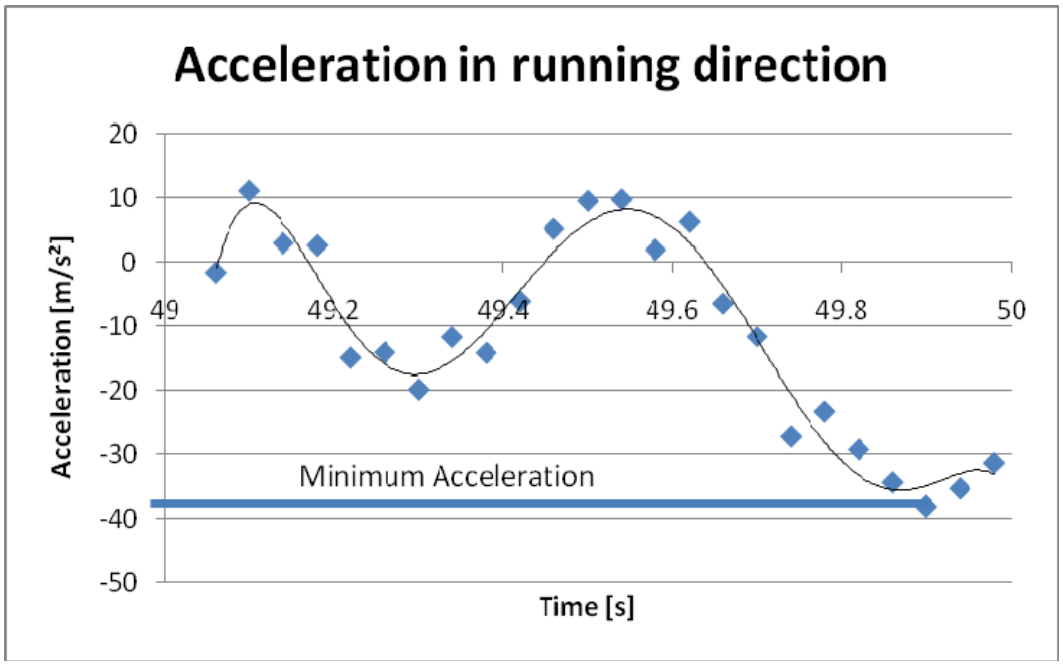

Figure 3 shows the horizontal acceleration of horse 1. The black line is the polynomial fit of the curve (6th order).

RESULTS: Table 1 shows the maximum acceleration of all horses (rider) in running and vertical direction. The main acceleration (deceleration) occurs in running direction. The values lay between -53.65 and -23.19 m/s².

Table 1 Maximum Acceleration of the Centre of Mass

Horse	Acceleration m.s^{-2}	
	Running Direction	Vertical
1	-38.15	3.65
2	-42.16	2.3
3	-35.36	8.95
4	-39	4.52
5	-38.1	12.01
6	-53.65	18.86
7	-33.73	8.94
8	-50.15	6.5
9	-25.69	1.01
10	-23.19	18.24
Mean	-37.92	8.50
SD	9.47	6.26

DISCUSSION: The usual load on the horses hoof is in the vertical direction. The sliding phase depends on the gait of the horse (walk, trot, gallop), but is commonly very short, compared to the sliding stop in Western Riding (Pardoe et al., 2001). It is obvious, that the acceleration in vertical direction is much smaller than in running direction. The mass of the analysed horses and rider were unknown to the authors. But if a mass of horse and rider between 500 and 700Kg is assumed, forces caused by the deceleration are in the range between 11.6 KN and 37.6 KN. This values are comparable to the load on the fore limbs when horse jump over a fence of one meter.

As it is shown in Figure 1, during the sliding stop the hind extremities are invisible. This limits this study, because the estimated stress to the hind limbs is inaccurate. Therefore question remains what are the effects of the sliding to the lower hind extremities of the horse and does it lead to injuries?

CONCLUSION: This study showed the enormous stress to rider and horse during the sliding stop; especially the hind limbs of the horse are used to decelerate. To avoid injuries for the horse a suitable training of horse and rider is essential; e. g. To start with lower speeds, use different grounds (lawn, sand) so that the horses will learn to adapt (Schöllhorn et al.,2009). Besides the training the appropriate equipment (Skid boots, sliding Plates) and the condition of the sand are crucial (Thomason and Paterson, 2008).

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