Article
https://doi.org/**10.61900/SPJVS.2023.03.05**

ANALIZE OF THE RIDER POSITION ON A HORSE SIMULATOR A CASE STUDY

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Abstract

The experimental study regarding the influence of the rider position on the horse simulator was conducted on the Racewood simulator. The evaluated results were compared on three different types of saddles. The experiment showed that is a very unique way to determine the impact of the designed equipment in horses, the position of the rider according to the center of gravity and also to measure objectively the outcome of the experience and reactions of the rider.

Key words: horse riding simulator, position of the rider, saddle

Introduction

In the world of equestrian sports every detail counts for the success or failure in competitions. Apart from genetics and environmental factors that contribute to the horse development, the performance it is also influenced by the training and rider. The rider could have a major impact on the result of performance given the psychological part of the rider-horse relation. It is known that the horse can perform different under different riders, so this relation it is also very important. A good example could be the difference that comes with the experience of the rider (amateur or professional riders). Mechanical horse-riding simulators consist of a device that mimics the movement of a real horse, generating between 50 and 100 three-dimensional physical movements (forward and back, left and right, up and down) (J.G. Dominguez-Romero *et al*, 2020). Mechanical horse-riding simulator (HRS) is a type of intervention based on hippotherapy, consisting of a robotic device with a dynamic saddle that imitates the movement of a horse. (Sung Y.H. *et al*,2013)

Based on the hippotherapy research literature, during riding, the rider's pelvis moves in a soft, rhythmic, and repetitive pattern, being a movement similar to that performed by our pelvis during normal human walking. (J.G. Dominguez-Romero *et al*, 2020) Repetitive movements improve postural coordination and rhythm and allow reciprocal movement, in addition to facilitating postural control through stimulation of balance reactions (Sung Y.H. *et al*, 2013) and adaptive behaviors and movement strategies, due to the changing environment in which the session takes place (Yoo J.H. *et al*, 2014). Maintaining the center of gravity within the support base while the animal is walking means that the human rider has to anticipate and compensate for postural adjustments by reducing the center of gravity in order to remain safe on a moving surface such as the rump of the horse, stimulating multiple sensory inputs and efferent outputs (Temcharoensuk P *et al*, 2015), providing continuous motor, visual, somatosensory, and vestibular inputs to the rider (Kim S. *et al* 2013).

The following study tries to reveal the importance of the rider experience on the horse performance. Of course, the saddle and the position of the rider on the horse will have an important impact.

The study was performed by the same rider, with different saddles, on the same simulator that can record the correctness of the riding and to spot the faults that the rider is doing and be able to identify the differences according to the different saddles.

MATERIAL AND METHOD

The study was realized as a experimental case study, on the Racewood horse simulator which analyzed the parameters of the rider position on three different types of saddles.

Racewood simulators

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Racewood products appeared in the 1990s, first created to follow a renowned jockey, with the aim of continuing to improve in his discipline. Gradually, other models were developed for all skill levels, from beginners to professional riders. The development team has worked closely with instructors and professional riders to ensure that the products meet the real needs of the field.

On the Racewood simulator are three sensors to detect the movements and pressure of the rider's legs on the simulator. Again, for the analysis of the results obtained, we used a code (0, +, ++, +++, ++++) according to the pressure exerted on the various sensors, thus:

- 0 : no pressure detected
- + : light pressure
- ++ : medium pressure
- +++ : significant pressure
- ++++ : very strong pressure

Different models are possible, for flat races only, or for horse riding in general. For the latter, there are different modes, for dressage, jumping, outdoor, cross etc. In our case, it was the riding model, as presented below (Figure 1).

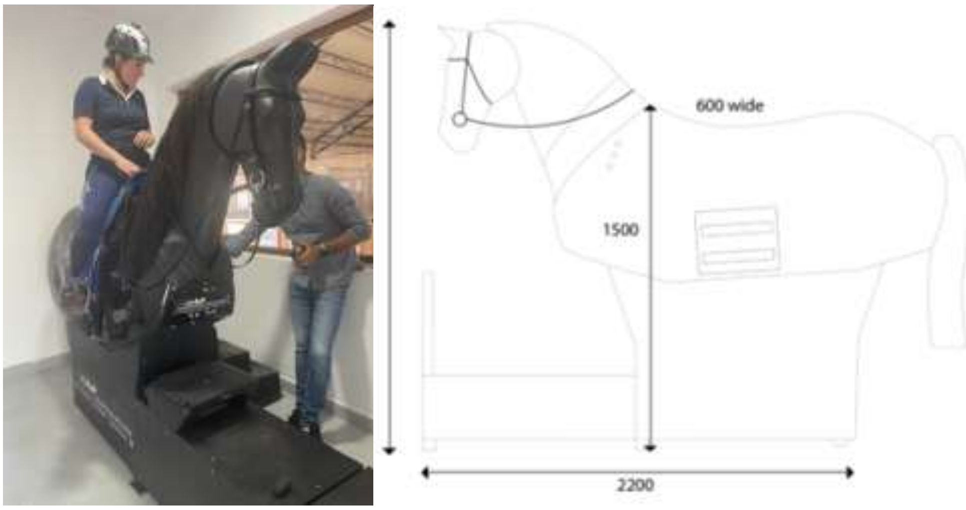

Figure 1 **Racewood simulator**

Multiple sensors are present to establish an idea of the most reliable position possible. There are sensors at the bridle to assess the impact of hand strength, sensors under the saddle and others for the legs. These are three in number, located behind the strap passage, one after the other. The latter are also used to request the start at a gallop during training on the simulator. Option for position analysis on the Racewood simulator

On the simulator, it is possible to train in different environments and on different activities, but there is also a position analysis mode. The analysis time is 2 minutes. It includes walking, trotting, and cantering with both hands. In front of the rider there is a screen, where you can see the evolution of the exercise and the live position.

We tested the position of one rider on the simulator under on 3 different saddles (Figure 2).

Each saddle has been tested twice, once for seated cantering, and a second time for balanced cantering. In Figure 3, we can observe different parameters for each gait: in A, we observe the distribution of the rider's load on the right or left on the saddle. In B, we observe the vertical movements of the rider on the saddle, forward / backward (F for "front" and B for "back"). In C', it is the center of gravity of the rider on the saddle and in C, it represents the movements of the rider, represented in the form of points of different colors according to the gait. In D we see the representation of the use of both hands. And to finish in E, the use of the legs can be observed, when the latter come into contact with the sensors 1, 2, or 3 (the 1 is close to the strap and the 3, the farthest).

To find a reliable way to get the datas, we created a positive and negative number code (figure 4). The evaluation of the rider's center of gravity (CG) is done along two axes: the vertical axis, i.e. the forward/back movements (Front/Rear), and the horizontal axis, i.e. the left/right movements (L/R). The displacements to the left of the CG with respect to the center of the saddle are presented by the values (in centimeters) negative, and positive if the CG is displaced to the right. Similarly, forward movements correspond to positive values and backward movements correspond to negative values.

1 2 3

Figure 2 **Saddles used on the mannequin (original) 1 a podium endurance saddle - Champion Desert seat in leather ; 2 Bua saddle; 3 Kieffer dressage saddle - Ulla Salzberger**

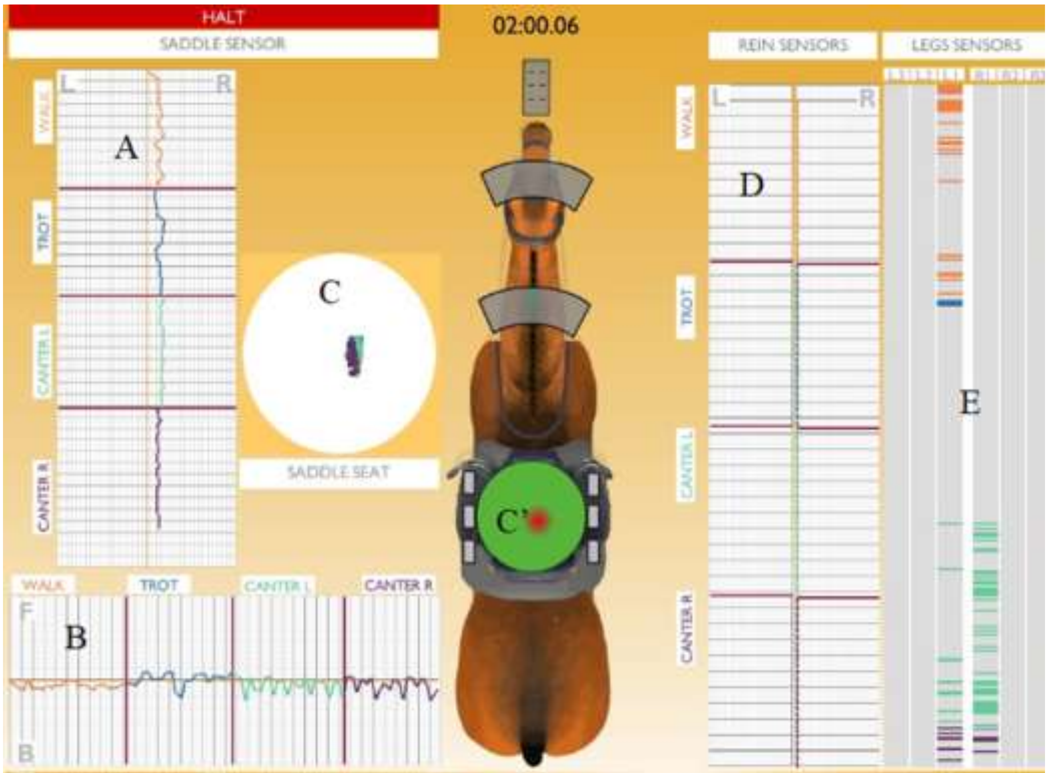

Figure 3 **Types of parameters that can be analyzed on Racewood**

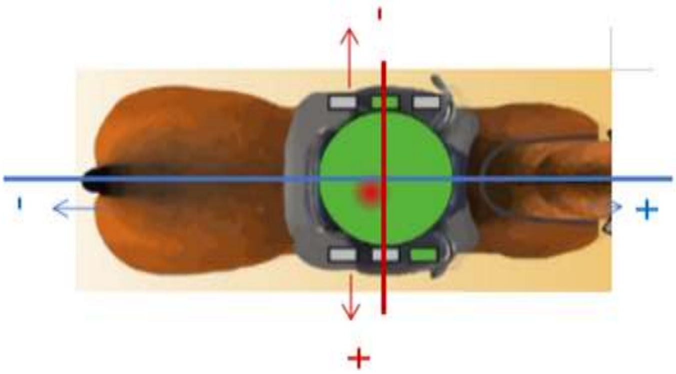

Figure 4: **Scoring method of the center of gravity value**

RESULTS AND DISCUSSION

The data obtained with the RaceWood simulator are presented in the same form as figure 11. No raw data in numerical value could be recovered. The results for the center of gravity were read using the grid scale. We note that the sensors under the saddle show position variations of 5 centimeters around its central point (1 square ≈ 0.25cm). The reading therefore remains very approximate because it is a visual evaluation of the curve. The results should therefore be taken with caution.

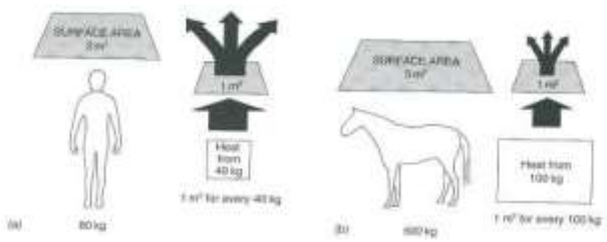

Figure 5 **Body surface area to weight ratio (Tribout P., 2013)**

In table 1, the results are noted at the top of the table and are accompanied by the position applied only to the gallop (measurements are in centimeters). After the collection of the data, we can see that, overall, regardless of the saddle used, the rider has the Center of Gravity shifted on average by 0.89cm to the right, which is therefore intrinsic to the rider.

On the other hand, we note a great variability Front/Rear of the Center of Gravity according to the saddle used at the walk: for the dressage saddle, the Center of Gravity is at point 0, it is therefore centered on the saddle, but if we compare it to the Bua saddle, the Center of Gravity is moved back 2 cm. The saddle therefore has a noticeable impact on the rider's Center of Gravity.

Table 1

Results for Center of Gravity (CG) according to the saddles types

	Podium seated	**Podium balance**	**Bua seated**	**Bua balance**	**Dressage seated**	**Dressage balance**
Center of Gravity Left/Right general galloping	0,75	0,75	0,75	1	1	1
Center of Gravity Front/Rear at walk	-0,25 0		-2 -1,75		0,25 0	
Center of Gravity Front/Rear galloping Left	0,25/-0,75	2,5/3	-0,75/-3	2,75/3,5	0,25/-0,75	2,5/3,25
Movement of the center of gravity Front/Rear galloping to Left	1	0.5	2.25	0.75	1	0.75
Center of Gravity Front/Rear galloping Right	0,25/-1	2,25/2,75	-0,75/-3	2,75/3,75	0/-0,75	2/2,75
Movement of the center of gravity Front/Rear galloping to Right	1.25	0.25	2.25	1	0.75	0.75

Logically, we find a Center of Gravity that is always more advanced when galloping in balance compared with galloping seated (Figure 6)

It can be seen that whatever the saddle used, the rider's center of gravity is always more stable when galloping in balance than when galloping seated. We were able to determine this by the ever-decreasing difference between the front/rear values when galloping in balance compared to when seated. For example, for the Bua saddle in seated gallop, the center of gravity moves over 2.75cm, against only 1cm in balanced gallop.

The changes observed between the right hand and the left hand (according to the different saddles and positions) are small and therefore cannot be interpreted in our study. We therefore averaged the median results for right and left hands, for all saddles and for both positions (Figure 7).

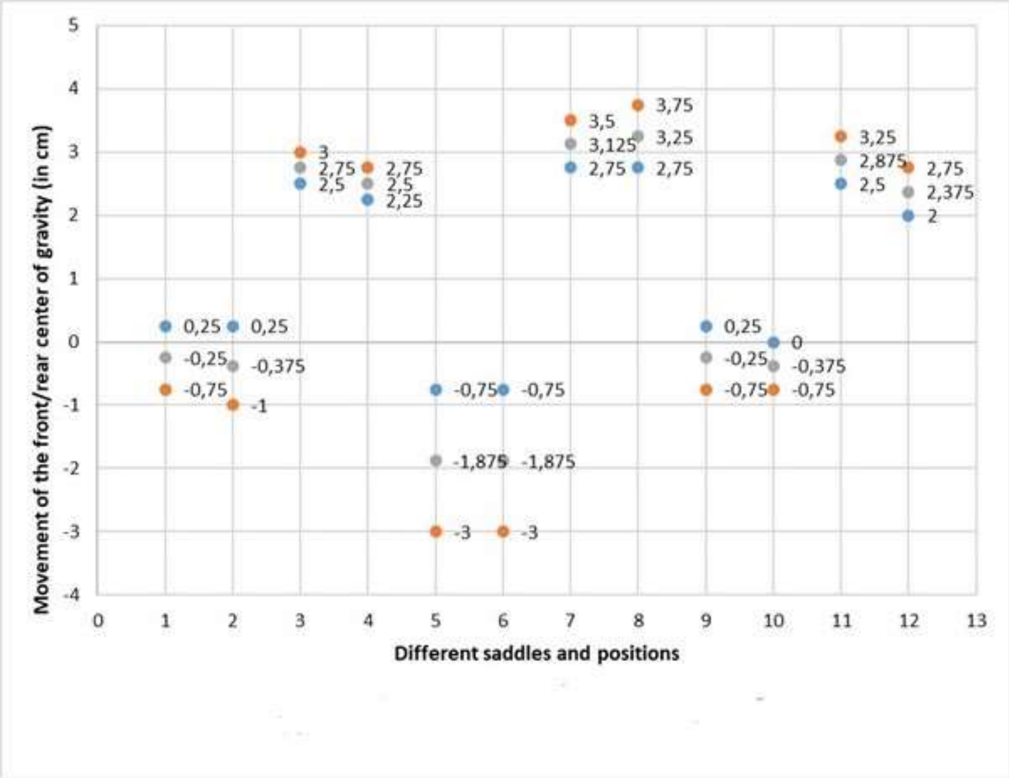

Figure 6 **Graphic representation of the front/rear Center of Gravity of the rider according to the saddle and according to the position**;

Legend:

- Average values of the most prominent positions
- Average values of the furthest back positions
- Averages of both

1: Left hand seated podium saddle, 2: Right hand seated podium saddle, 3: Left hand balanced podium saddle, 4: Right hand balanced podium saddle, 5: Left hand seated Bua saddle, 6: Right hand Seated Bua saddle, 7: Left hand balance Bua saddle, 8: Right hand balance Bua saddle, 9: Left hand seated Dressage saddle, 10: Right hand seated Dressage saddle, 11: Left hand balanced Dressage saddle, 12 Right hand balanced Dressage saddle.

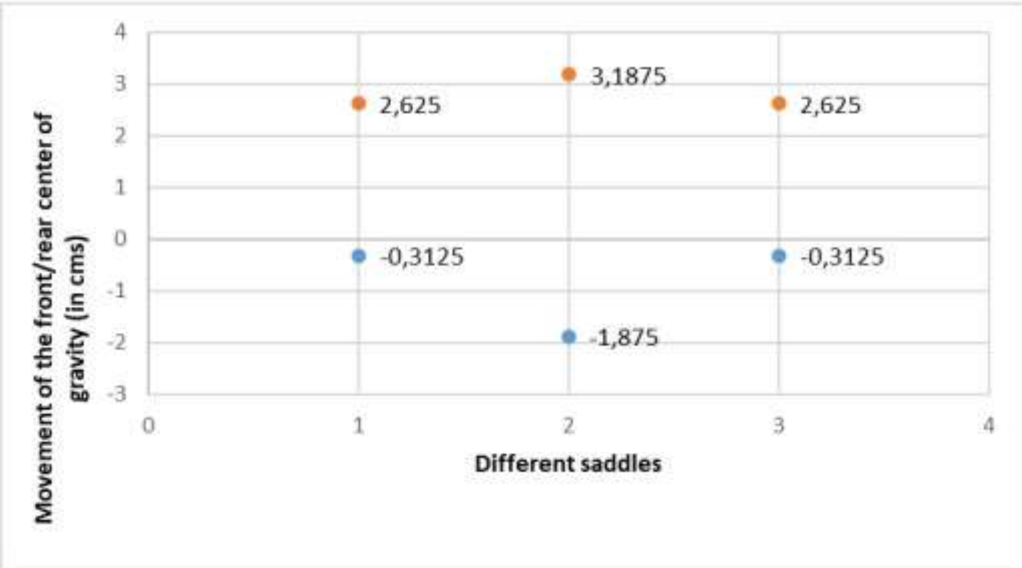

Figure 7 **Graphic representation of the rider's average Front/Rear Center of Gravity according to saddle and position**

Legend

- Seated averages
- Average equilibrium

1: Podium saddle, 2: Bua saddle, 3: Dressage saddle

It is observed that the Center of Gravity averages are identical for the Podium saddle and the Dressage saddle. We therefore probably have the same range of motion in the saddles: seated, the Center of Gravity is slightly moved back from the center of the saddle (0.31cm), and forward of the center for the balanced position (2.63cm). When the rider moves from a seated position to a balanced position, the Center of Gravity is moved forward (2.94cm). For the Bua saddle, its Center of Gravity is shifted 5.06cm forward when passing into balance.

The results that we obtained are presented in the tables 2 and 3 according to each saddle used.

For the gallop seated on the left hand, the left leg is at the strap, and only slightly touches L1; the right leg is slightly more in contact with R1. This corresponds to a classic position for galloping (left leg at the strap and right leg moved back).

For the gallop seated on the right hand, the same situation is found, but reversed (right leg at the strap and left leg moved back).

For the balanced gallop, the legs are further back because they come into contact with the Sensors 2 and 3. As for the seated gallop, we find a slight gap between the two legs (legs with the strap/leg back). In addition, we find that the pressure exerted on the sensors is greater when galloping in balance compared to galloping seated.

Table 2

Results of the pressure exerted on different sensors by the rider for the Podium saddle

	PODIUM SEATED		PODIUM BALANCE	
	Gallop Left	Gallop Right	Gallop Left	Gallop Right
L1 (Sensor 1 Left)	+	++	+	0
R1 (Sensor 1 Right)	++	+	0	+
L2 (Sensor 2 Left)	0	0	++++	+++
R2 (Sensor 2 Right)	0	0	+++	+++
L3 (Sensor 3 Left)	0	0	0	0
R3 (Sensor 3 Right)	0	0	+++	+

Table 3

Results of the pressure exerted on different sensors by the rider for the Bua saddle

	PODIUM SEATED		PODIUM BALANCE	
	Gallop Left	Gallop Right	Gallop Left	Gallop Right
L1 (Sensor 1 Left)	++++	+	0	No results registred
R1 (Sensor 1 Right)	+++	++++	0	
L2 (Sensor 2 Left)	0	+++	++++	
R2 (Sensor 2 Right)	+	0	++	
L3 (Sensor 3 Left)	0	0	+	
R3 (Sensor 3 Right)	0	0	+++	

For the left-hand seated gallop, the left leg is behind the strap, it touches the L1 sensor with significant pressure. The right leg is slightly further back and touches R1-R2, (left leg at the strap and right leg back).

For the seated gallop with the right hand, the same situation as with the left hand is observed but reversed (right leg just behind the girth and left leg further back).

For the balanced gallop, the legs are further back because they come into contact with sensors 2 and 3. As for the seated gallop, we find a slight gap between the two legs (legs with the strap/leg back). We have no data recorded for canter to the right in balance.

For the Keiffer saddle, whatever the position and the hand, the legs do not touch the sensors, they remain at the strap and are fixed, without perceptible movements , so that the sensors on the simulator were not activated and thus they dint registered any results.

CONCLUSION

In scientific literature, there are few reports for the applications of the horse riding simulators, so our study is a case study that is original and needs further development to apply this methodology at a large scale.

Through this study, we can conclude that the rider s center of gravity is offset to the right regardless of the saddle used. In this study, it differs according to the saddle used, thus clearly showing an impact of the saddle.

The balanced position moves the Center of Gravity forward compared to the sitting position, and this difference in Center of Gravity depends, among other things, on the saddle.

The balanced position seems to give a more stable Center of Gravity in the movement than if the rider is seated: the difference between the extreme values is reduced.

The movement of the legs depends on the saddle used. The dressage saddle induces a good position of the legs of the rider: they are fixed to the strap. For the other two, the legs are further back compared with the dressage saddle. In conclusion, for these last two saddles, the position of the legs in balance is further back than in the seated gallop.

After analyzing the results of evaluation for the three saddles for the Center of Gravity and the movement of the legs, we can conclude that the most suitable saddle for the rider is the dressage saddle.

The Racewood system it is an important tool for training of the riders, professionals or amateurs, because it can help preparing the riders before mounting a real horse, thus without having a possible negative impact on the real horse. Also, it is an important way to evaluate accurately the rider's performance and can help him progress to a superior level. Another important fact is that it helps the riders understand the processes and the mechanics involved in equestrian sports. For the research, we consider that is a unique way to determine the impact of the designed equipment in horses, the position of the rider according to the center of gravity and also to measure objectively the outcome of the experience and reactions of the rider.

ACKNOWLEGMENTS

This work was conducted in partnership with SC ROSANCO TRADE SRL.

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