Pferdeheilkunde 12 (1996) 4 (Juli August) 393–396

Welfare of sport horses: Role of the rider

B. Auvinet[1], C. Coureau[1] and P. Galloux[2]

[1]Unité de Médecine du Sport Humaine et Equine Comparée (Pégase Mayenne), Centre Hospitalier, Laval Cedex, France
[2]National Equestrian School, Saumur, France.

Introduction

Horse riding includes a large variety of disciplines and practices: dressage, showjumping and three-day event are the three Olympic ones. So, it appears extremely difficult to have a physiological overview of horse riding. On the other hand, it is a habit to consider horse riding as a sport for the horse and not for the rider, who is sometimes called the "passenger". Nevertheless, the rider has to be taken into account in order to improve the welfare of sport horses. This point of view can be illustrated using three different studies:

- riding energy expenditure during training and competition;
- physiological profile of the rider by means of the evaluation of the maximum oxygen uptake (VO_2 max) ;
- biomechanics in dressage riders.

Riding energy expenditure during training and competition.

Under field conditions, it is usual to evaluate the energy expenditure by means of the heart rate recording associated with the blood lactate measurement. This methodology was applied to riders during riding lessons and competitions.

Methodology and population

A first population composed of 9 student instructor riders (3 females, 6 males) was followed during riding lessons at the National Equestrian School in Saumur. They were aged from 22 to 44 years old, with a mean value of 27 years-old. This population was divided into 3 groups according to 3 types of riding lessons:

- group I: rider education
- group II: horse education
- group III: jumping education.

A second population, composed of 9 male riders aged from 20 to 35, was followed during 2 major three-day events: Compiègne in June 1985, and Le Lion d'Angers in October 1986. These 2 events included the five classic phases.

- 1st road and track
- steeple chase
- 2nd road and track
- 10 minutes rest period
- cross-country.

The heart rate (HR) was recorded using a PE 3000 HR monitor (Polar Electronics, Finland) during the riding lessons at the National Equestrian School and during the Lion d'Angers 3-days event. During the Compiègne event, HR was recorded using a Holter apparatus. Blood lactate determination was done with capillary haemolyzed blood taken between 1 and 3 minutes after the intensive part of the riding lesson and after the cross-country.

For the first population, HR and blood lactate were measured from all the student instructor riders during the 3 types of riding lessons. For the second population, 2 riders during the Compiègne 3-day event and 2 other riders during Le Lion d'Angers 3-days event had HR and blood lactate measurements. Furthermore, 3 riders during the Compiègne 3-days event and 2 riders during the Lion d'Angers 3-days event had blood lactate determination.

Heart rate profile.

During riding lessons, which lasted one hour, HR recording was done during all the lesson and blood lactate measurement was done after the most intensive part of each of these lessons. It appeared that the intensive part of these lasted from 3 to 5 minutes in group I, 4 to 5 minutes in group II and 2 minutes 30 seconds in group III. The HR values ranged from 120 to 165, 130 to 180 and 150 to 180 beats per minute (bpm) in these 3 groups respectively (Table 1).

During the three-day event the HR pattern was the same for all riders (Fig 1), with an intermediate level during the first and second road and track phases, and a high level during the steeple chase and cross-country (Table 2). More precisely, during the steeple chase which lasted 3 minutes, the HR remained constant with mean values of 192, 198, 190 and 165 bpm. During the cross-country event, which lasted between 8 and 9 minutes, the mean values were always high amounting to 204, 202, 195 and 174 respectively. In addition, during the cross-country event, the HR increased progressively with peak values of 214, 210, 201 and 180 bpm.

Blood lactate level

During riding lessons the mean blood lactate level was very different from one group to another. It rose from 1.8 mM in group I to 3.3 mM in group II and to 4.2 mM in group III (Table 1). Blood lactate concentration after the cross-country phase of the Compiègne event ranged from 5.3 to 14.2 mM with a mean value of 9.2±3.4 mM. During the Lion d'Angers event the blood lactate ranged from 4.5 to 6.0 mM with a mean value of 5.0±0.7 mM (Table II).

Physiological profile

A population of 14 French top level riders was studied in 1984, before the Los Angeles Olympic Games. It was composed of 10 male riders (mean age value 23, extreme age values 18–36 years), and 4 female riders (mean age value 25, extreme age values 20–29 years). They had a complete medical examination which included the measurement of oxygen consumption by means of a bicycle ergometer maximal test. These tests were performed in

Tab. 1: Heart rate and blood lactate concentration of riders during training.

Group	Age (years)	Heart Rate Range (bpm)	Blood lactate (mM)	High intensity exercise duration
Group I	22	145–165	1.9	3 min
	24	145–155	2.1	4 min
Rider education	31	120–130	1.4	5 min
Group II	25	130–140	3.5	5 min
	27	140–165	3.0	4 min
Horse education	25	160–180	3.5	5 min
Group III	26	160–165	3.2	2 min 30 sec
Jumping	25	170–180	4.5	2 min 30 sec
education	44	150–155	4.9	2 min 30 sec

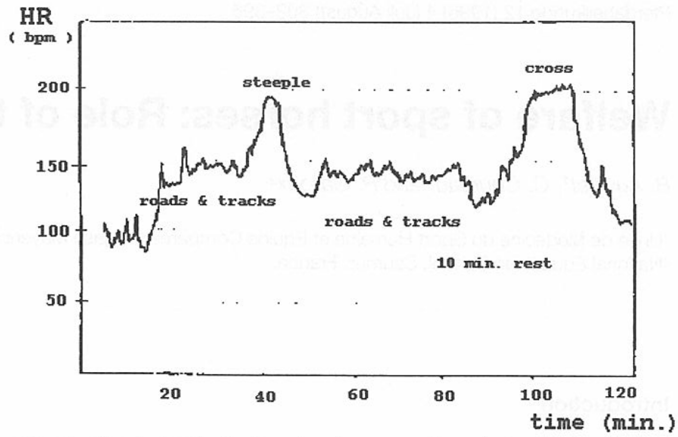

Fig. 1: Typical rider's heart rate recording during a three day event

Tab. 2: Heart rate values and blood lactate concentration during 3-day event.

	Rider age (years)	1st road and track phase	Steeple chase	2nd road and track phase	Cross country		
		Mean Hr (bpm)			Mean Hr (bpm)	Max. Hr (bpm)	Blood lactate (mM)
Compiègne 1985	29	145	192	142	204	214	9.0
	29	144	198	154	202	210	10.3
	24	–	–	–	–	–	5.3
	32	–	–	–	–	–	7.2
	30	–	–	–	–	–	14.2
Lion d'Angers 1986	20	165	190	150	195	202	4.5
	30	130	165	130	174	180	6.0
	35	–	–	–	–	–	4.7
	29	–	–	–	–	–	4.7

Tab. 3: French top level riders: maximum oxygen uptake (1984)

Population	Age (years)	VO_2 max ml.min^{-1}.kg^{-1}
male n = 10	mean = 23 range = 18–36	mean = 52 range = 38–68
female n = 4	mean = 25 range = 20–29	mean = 45 range = 43–49

different centres, all approved by the French National Olympic Committee.

In the male rider group, the VO_2 max ranged from 38 to 68 ml.min^{-1} .kg^{-1} with a mean value of 52 ml.min^{-1} .kg^{-1}. In the female rider group, the VO_2 max ranged from 43 to 49 ml.min^{-1} .kg^{-1}, with a mean value of 45 ml.min^{-1} .kg^{-1} (Table 3).

Biomechanics in dressage riders

In 1976, the biomechanics of horse riders in dressage was studied on 2 male riders aged 30 and 31. The aim was to bring about a medical explanation for the specific adaptation necessary for the rider, mainly in dressage practice during the trot. Our references were horseback riding literature, by classical authors such as *L'Hotte* (1967), *Museler* (1967) and *Saint Fort Paillard* (1975). These authors recommended firstly a good basic position and then specific movements complementary with those of the horse. The basic position was a seated position with a moderate retroversion of the pelvis, and the specific movement was an accentuation of the pelvic retroversion which had to be simultaneous with the horse back elevation. The wrong movement would be an active pelvic anteversion.

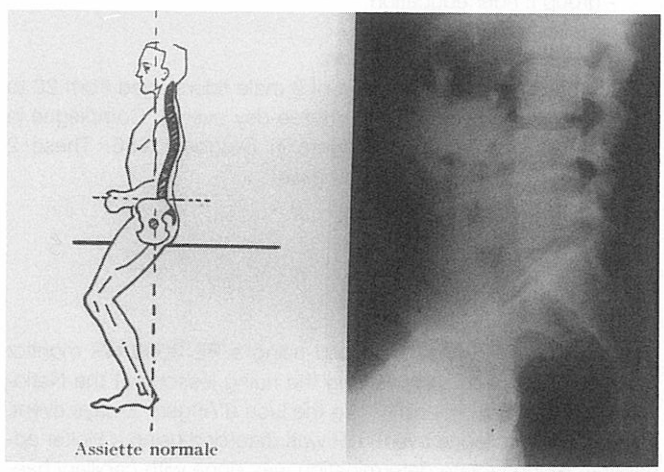

Fig. 2: Normal seated position
Moderate retroversion of the pelvis
Reduction of the normal lordosis
Equal distribution of the pressure in the intervertebral discs

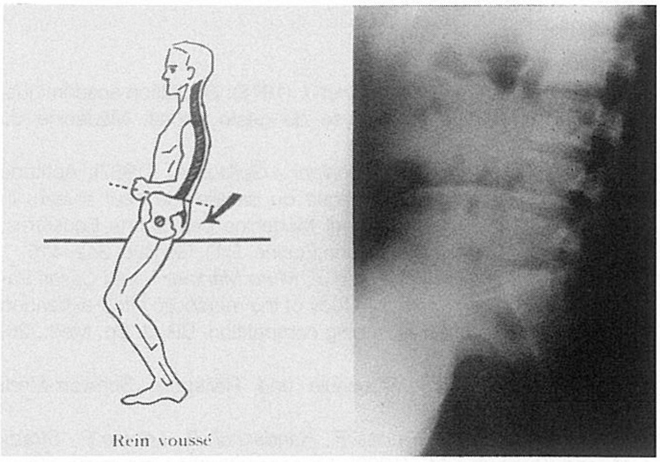

Fig. 3: Rounded lumbar spine position
Accentuation of the pelvic retroversion
Flattening lumbar lordosis
The 2 main intervertebral discs (L4 - L5, L5 - S1) remain parallel.

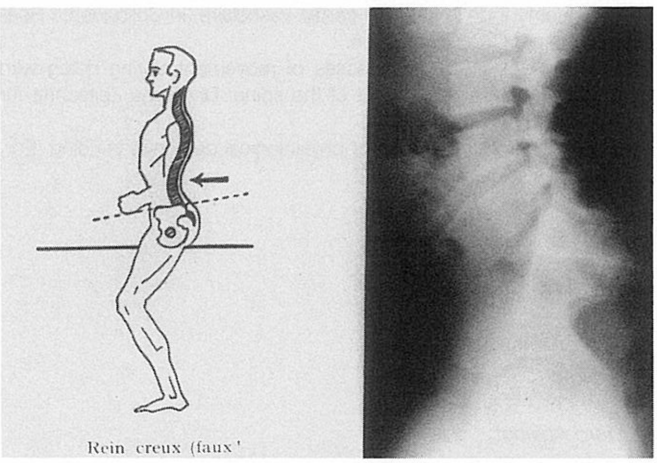

Fig. 4: Hollow back position (wrong)
major pelvic anteversion and hyperlordosis
strong narrowing of the intervertebral discs in their posterior part

In these 3 positions, we carried out a radiographic analysis of the pelvic position and studied the consequence for the lumbar spine (Fig 2, 3 and 4). In the basic position, a reduction of the normal lordosis was observed with an equal distribution of the pressure on the intervertebral discs. In the "rounded lumbar spine" position, there was an accentuation of the pelvic retroversion which led to a flattening lumbar lordosis, and the 2 main intervertebral discs remained parallel. Nevertheless, a slight kyphosis appeared at the upper part of the lumbar spine. In the "hollow back" position, which was a consequence of pelvic anteversion, a major hyperlordosis appeared, with a strong narrowing of the intervertebral discs in their posterior part. This situation would cause disc degeneration and chronic facet syndrome. So, from a medical point of view, it appears that the right pelvic movement education for the rider is a crucial point in order to prevent lumbar pain. Furthermore, wa can assume that this riders' pelvic education is of importance for the horse's locomotion (*Auvinet*, unpublished data).

Discussion

The energy expenditure during riding lessons has not been the object of many studies. It appears necessary to differentiate various types of riding lesson. Rider education lessons seem to be purely aerobic (mean blood lactate 1.8 mM). Horse intensive education (trot or gallop) and jumping education lessons require a higher energy expenditure which nevertheless remains at an intermediate level: 3.3 and 4.2 mM. These results are in accordance with those of *Westerling* (1983) who studied oxygen uptake, pulmonary ventilation and heart rate during riding and walking, trotting and cantering. He found that the average oxygen uptake of experienced riders in sitting trot was 1.70 $l.min^{-1}$, rising trot 1.68 $l.min^{-1}$ and canter 1.80 $l.min^{-1}$. The experienced riders used at least 60% of their maximal aerobic power in trot and canter, which was an exercise intensity that might induce some training effect. Nevertheless, we have to discuss the duration of high intensity exercise during riding lessons which was less than 5 minutes in our study, and we assume that this duration is insufficient to develop the rider's aerobic capacity.

In contrast, horse riding can involve high energy expenditure, especially during a three-day event. Data obtained show that there is a major anaerobic participation during the cross-country phase. These results are similar to those from *Gutiérrez-Rincon* et al (1992) study, carried out during showjumping. They observed that the riders' HR could reach more than 90% of their maximal HR. They also found that the blood lactate ranged from 5.0 to 6.3 mM, 3 minutes after a 45–60 second showjumping test. This participation of anaerobic pathway during showjumping and cross-country was confirmed by the blood level observed after the cross-country phase, which could reach a value of 14.2 mM. But, we have to consider the range of the blood lactate values observed after the cross-country phase which varied from 4.5 to 14.2 mM among the riders.

In order to explain these differences we have to take into account:

- the riding skill of the rider;
- the behaviour of the horse which is contingent on the performance of the rider;
- the difficulty of the event.

These different points explain why men and women compete in riding on equal terms even in the Olympic Games. In order to take into account the welfare and the health of their horses, riders should be careful with their own fitness. To ensure this, an additional sport practice seems necessary such as skipping and cycling.

Few data exist on the physiological profile of the rider. Regarding maximal oxygen consumption, our results are in accordance with those from *Vogelaere* et al. (1982) and *Westerling* (1983). *Vogelaere* et al (1982), in their study conducted with 2 groups of 15 male riders from the National School of Military Police in Belgium, found a VO_2 max of 45.5±11.9 $ml.min^{-1}.kg^{-1}$ in the first group and a VO_2 max. of 55.1±12.2 $ml.min^{-1}.kg^{-1}$ in the second one. The difference was explained by an additional one year exercise programme. In another study, *Westerling* (1983), used a group of 13 experienced women riders who rode between 3 and 14 hours per week. He found a VO_2 max. of 43.3±4.0 $ml.min^{-1}.kg^{-1}$. All these results indicate that riders, even professionnals, have a moderate aerobic capacity. In comparison with the VO_2 max of different French national sport teams (*Jousselin* et al 1990) it appears that riders almost have the lowest level compared to other sports: men's VO_2 max ranged from 52.2 in canoeists to 80 $ml.min^{-1}.kg^{-1}$ in marathon runners ; women's VO_2 max ranged from 42.8 in fencers to 68.9$ml.min^{-1}.kg^{-1}$ in marathon runners.

Concerning the biomechanics in dressage riders, little can be found in medical litterature. Our results are in accordance with those previously published by *Hordegen* (1975). These authors insisted on the rider's active pelvic retroversion during the horse's back elevation and with a passive pelvic anteversion when the back of the horse is going down. So during the motion of the trot there was a tipping of the pelvis with an approximate range of 20° between the extreme values of pelvic forward and backward (*Von Gottwald* 1980). But in another study (*Auvinet* et al 1978), we found that the requirement for the dressage rider to have their legs in a lowered position is in contradiction with an active retroversion of the pelvis. The legs in the lowered position placed the hip flexor muscles in tension and in this situation these muscles provide an anteversion of the pelvis and bring about hyperlordosis. So the rider has to take care of having a wide possibility of hip extension (by means of stretching exercises) in order to have sufficient mobility of the pelvis and especially for the active retroversion pelvic movement with legs in lowered position.
In addition we can assume that the biomechanics of riders has consequences on the biomechanics of the horse. Firstly, the two movements of the rider and the horse have to be synchronised, secondly the active motion of both have to be in the same direction: forwards and upwards for the horse's back, active pelvic retroversion for the rider. These 2 points are strictly necessary for good dressage presentations. Further studies are however required in order to have a better understanding of the consequences of the rider motion on the movement of the horse.

Conclusion

It is unusual to take into account the role of the rider necessary to improve the welfare of sport horses, and yet sometimes horse riding, such as three-day event, can require high energy expenditure (aerobic and anaerobic) from the rider. On the other hand, it is not usual to focus on the rider's fitness, and as other authors, we observed a fairly poor development of the VO_2 max in riders. So, sometimes, we can assert a rider with maximum fitness could be a requirement for the welfare of both the rider and the horse. In other practices, such as dressage, the biomechanics of the rider appeared to have major consequences on horse dressage presentation. Further studies are necessary in order to gain a better knowledge on the role of the rider's fitness and riding for the welfare of sport horses.

References

Auvinet B., Guiheneuc P. and *Ginet J.* (1978): Equitation académique, adaptation du cavalier, analyse du geste sportif. Médecine du Sport, 52, 11.335–15.339

Auvinet B., Coureau C. and *Ansaloni - Galloux A.,* (1987): Aptitude physique et dépense énergétique du cavalier de haut niveau. In Congrès de Chirurgie Equine et Médecine des Sports Equestres, (Association Suisse de Médecine Equine, Ed.), Genève, 342–415.

Gutiérrez Rincon J.A., Vives Turco J., Muro Martinez I. and *Casas Vaqué I.* (1992): A comparative study of the metabolic effort expended by horse riders during a jumping competition. BR. J. Sp. Med., 26, 33–35

Hordegen KM (1975): Wirbesaüle und Reitsport. Schweiz-Med. Wschr, 105, 668–675.

Jousselin E, Desnus B., Fraisse F., Handschuh R., Legros P., Strady M. and *Thomaïdis M.*, (1990): La consommation maximale d'oxygène des équipes nationales françaises de 1979 à 1988 (sportifs de plus de 20 ans). Sciences et sports, 5, 39–45.

L'Hotte (1967): Un officier de cavalerie. Souvenirs du général L'Hotte. Charles Lavanzelle Edit., Paris.

Museler W. (1967): Equitation. Berger-Levrault Edit., Paris.

Saint Fort Paillard J. (1975): L'équitation. Chiron Edit., Paris.

Vogelaere P., Moonen G. and *S'Jongers J.J.* (1982): L'équitation et l'entraînement de la fonction cardio-vasculaire. In Colloque La Rééducation par l'Equitation, Bâle.

Von Gottwald A (1980): Processes of movement during riding with special reference tmovement of the spine. Deutsche Zeitschrift für Sportmedizin, 6, 172–178.

Westerling D. (1983): A study of physiological demands in riding. Eur. J. Appl. Physiol, 50, 373–382.

Bernard Auvinet

Unité de Médecine du Sport Humaine et Equine Comparée
(Pégase Mayenne),
Centre Hospitalier,
F-53015 Laval Cedex
Tel: 33 43 66 51 60
Fax: 33 43 68 19 26