

**“A Happy Athlete”
or an
“Addicted Sports-
Tool” for the Top-
Rider?**

*By Eva Lydeking-
Olsen, Denmark*

“A Happy Athlete” or an “Addicted Sports-Tool” for the Top-Rider?

By Eva Lydeking-Olsen, Denmark

In equine sport, doping as well as the non-natural training and warming-up technique of hyperflexion of the neck, is excessively debated, over the past few years. The two might be linked by physiological effects of hyperflexion, on the brain.

Research on the physical effects of hyperflexion is limited and often of doubtful scientific quality. Others have put forward papers and books on the biomechanical issues related to hyperflexion, but so far none have looked into the possible neuro-chemical-behavioral (side) effects of this practice.

The FEI-Veterinary Committee in 2008 adopted a stance on Hyperflexion (Rollkür) saying that "There are no known clinical side effects specifically arising from the use of hyperflexion, however there are serious concerns for a horse's well-being if the technique is not practiced correctly. The FEI condemns hyperflexion in any equestrian sport **as an example of mental abuse**. The FEI states that it does not support the practice."

This was not supported by the rest of the FEI- at that time- but recently the issue was surfacing again, with the video documentation of a rider using rollkur for 1,5 hour in one stretch during a FEI competition in Denmark.

On the other hand, proposers of the use of hyperflexion, states that the horses work happily, willingly and “like it”. Also that hyperflexion is only used for “short moments” and on educated horses.

Personally I wanted to see for myself. I have, as a nutritionist educated also in human public health, worked with teaching and reasearch in the connection between neuro-chemistry and nutrition in relation to human psychiatry, stress, developmental disturbances etc. and are thus familiar with reading scientific reasearch, combining information from different sources and on different levels- making a synthesis and coming up with new hypothesis on “how and why”.

I went to the World Cup qualifier in dressage in Odense, Denmark in 2006. Together with a friend, I spent most of two days in the warm-up arena making notes of the horses:

- * Time they were ridden rollkur in morning training or warm-up
- * Physiological expression: Difference between horses NOT ridden rollkur and horses ridden rollkur with respect to respiration, sweating, expression of the eyes, behavior in the show ring, price giving ceremony etc.

Personally, I witnessed two of the dutch riders and one french lady (names omitted) riding rollkur for periods of 13-15 minutes, then 1-2 minutes break, then 13-15 minutes rollkur again, just before entering the show arena.

In “morning training” rollkur for one hour (60 minutes) without any interruption happend – so the explanation of “short moments” did not fit reality, to say the least.

Rollkur for one hour – a lot of the time in canter, produced a profusely sweating, fearful and exhausted horse- the groom was wiping off sweat-foam every few minutes, but the horse never had its full range of movement in the neck or was permitted a long rein and some relaxation after a period of hard work.

Later the same day, the horse was again ridden rollkur, for 2 x approx 15 minutes in the warm-up and in the show-arena completely refused to cooperate. Most of the dutch horses “did their job” and completed their classes. The discrepancy between the *expression of the horses* in the warm-up, compared to the show arena, was striking, making me think of “relief” in the show-ring.

Since then, a huge amount of video material have popped up, primarily on [youtube.com](https://www.youtube.com), documenting that horses are ridden rollkur for far more than short periods and that a variation of conflict behavior often occurs in these horses (exited mouth, tail swinging, tonque problems, flight behavior during price-giving ceremonies etc).

Compared to the more classically ridden horses (names omitted), all the rollkur ridden horses had a MUCH more laboured breathing during the warm-up, specially in the canter- a clear indication of restricted air-flow.

This observation made me think around rollkur in another way than the biomechanical (dis)advantages, the sensory deprivation, the risk of neck-ligament damage, the lack of control in unexpected situations etc. that have been brought forward by others:

What happens in the brain with prolonged physical work under limited oxygen supply ?? Could the horse “become addicted” ?? Could the horse enter a (dependency) state of altered brain- chemistry and thus “look happy” in the show ring, on the (physiological) basis of this special, extreme way of training and warming-up??

I did a litterature search and looked into the consequences of physical work under limited oxygen supply, for the brain. This research has largely not been done in horses (as it would be difficult), but most mammals does not differ that much in these areas, and the results is so interesting, that I feel compelled to bring this hypothesis forward. And some of the studies are in horses.

Doing research “all the way round” this subject, would need to adress the following issues:

1. Physical- biomechanical:

Neck-ligment damage with calcification of the attachment btw. cranial crest and ligament.
Clean-ness of movements, rhytm and ability to perform true collection

2. Sensory and emotional:

What happens in the stress-response of the horse *during the ride*, when the control of the sight is minimized ?? And the horse is forced into a non-natural position for a prolonged time ?

Relation of sensory deprivation to hyper-sensitivity and conflict behavior?

Most mammals have, more or less, the same emotional reactions, in the same parts of the brain- so even if horses do not have the mental- intellectual capacity of human beings- they can still react emotionally to pressure (specially from the bit) they do not “understand” and can not get released of.

Why is it allowed to warm –up with draw-reins in FEI competition/ morning training?? This should be the top-leading-riders of the world, they should be able *to ride* and *collaborate with* their horses, not force them??

Research into both hyper-reactivity and learned helplessness is needed, both from an learning-behavior and an endocrine perspective.

3. Brain- chemistry:

Working hard (involving many muscle groups in demanding exercises) for a prolonged time with the head and neck curled up or down in hyperflexion, decreases the airflow relative to the demand

of the physical workload. It is easy to hear that the breathing is compromised during rollkur, exceeding some minutes, specially in canter, where the demand for energy and oxygen/carbon-dioxide exchange is larger than in the walk and trot.

A human analogue would be to take a run (a half marathon?) with a tight scarf around the neck.

Working like this, is working with less oxygen and more carbon-dioxide in the circulation, the muscles and other tissues, than for the same workload with unrestricted airways (head and neck in natural dressage- position).

Many physiological reactions and processes will thus be altered:

Production of red blood cells

Working with less oxygen than the muscles “optimally demands” makes the body produce more red blood cells, thus increasing the transportation of the available oxygen. In those periods where the horse is not ridden rollkur (in the show arena) it might get a larger physiological reserve capacity regarding oxygen transportation under workload. Studying rollkur-ridden horses hematocrit-value would clarify if rollkur acts like a form of blood-doping (like transfusions and EPO in bicycling)??

Acid- alkaline displacement and activation of the endogenous doping-system??

When the horse has performed for some time under restricted airflow and sub-optimal oxygen supply, carbon dioxide is increased, shifting the acid-alkaline balance in the blood, the muscles and the brain in acidic direction. Acid- accumulation will give the well known muscle soreness/pain, but with increasing training, the capacity for handling this, is also increased (Taylor 1994).

For the muscles, this is not problematic, but the effect of acidification on the nervous- and endocrine system is less known:

*** Release of endorphins which is one of the body’s natural morphine- substances** (Melrose 1988, Taylor 1994).

Endorphins is a group of substances released during stress, from many different tissues- for example both adrenals and brain. Endorphins is created from the precursor POMC (pro-opio-melano-cortin) and includes the substances ACTH, stimulating the adrenals to secrete the stress-hormones adrenaline, noradrenaline and cortisol; 16 K (less known); alfa-MSH (alpha- melanocyte-stimulating hormone), influencing behavior and memory in pro-stress direction; enkephalins that are painkilling, dynorphins (cause nausea and other “side effects”) and **beta- endorphin**.

Beta-endorphin is the best researched of these natural, endogenous morphines-like substances:

* It increase the feeling of well- being, increasing to euphoria and addiction

* Act as a strong pain-killer

* Decrease stress- experience, by decreasing release of other stress- hormones (Melrose 1988, Dunbar 2000, Soverchia 2006, Terenius 2000)

* In the adrenals, the release of stress- hormones is lowered, the blood-pressure as well (Dunbar 2000).

* During exercise **with sufficient oxygen supply** the acidification (lactic acid) and also the production of endorphins, **is held stable**. When workload is increased to near- maximum for the individual the acidification is increased and the production of **beta-endorphin is doubled** (Mehl 2000).

* In endurance sport, the mechanism is, as long as there is sufficient oxygen supply for balancing the creation and excretion of lactic acid, the blood amount of endorphins is stable for the first hour, after which it increases exponentially (Schwarz 1992).

*Endorphin level in horses is high at least one hour after exercise (Kokkonen 2002) and for exercise to exhaustion the level is 24-32 hours to normalize (Golland 1999 a).

* In horses there is a diurnal variation in creation of beta- endorphin with peaks around 9.00 og 15.00, where the horse is less sensitive for pain or pressure (Hamra 1993)

* There exists a environmental relation with respect to temperature and humidity, as with 20° C in dry air, all stress- hormones is increased and beta-endorphin to a certain level, but in 30° C and humid air the values are much higher (Williams 2002).

In short, endorphins in mammals have the following effects:

1. Intimately involved in regulation in several transmitter- pathways in the central nervous system (Dunbar 2000)

2. Downregulates stress- response after training/exercise

3. Painkilling

4. Can induce euphoria and with-drawal-symptoms. Humans can become addicted to endorphins via hard exercise, but this subject is not reaeached in animals.

5. Decrease the memory for training-related learning

(Izquierdo 1980), both for avoidance of unpleasant pressure (in horses, negative reinforcement) and in spatial sense of direction (in horse motorical education ie dressage-exercises) (Introini-Collison 1995)

6. Decrease the storage of information via noradrenaline - activation in amygdala in the limbic system in the brain (Introini-Collison 1995)

Acid- alkaline displacement will also influence the effect of other signal- substances in the nervous system, like dopamine, serotonin etc- but these are less researched with respect to horses and training effects.

Stress-hormones

* The well known stress-hormones from pituitary and adrenals (ACTH, cortisol, adrenaline and noradrenaline) is increased as a physiological regulator and protection against damage (Rose 1988). In overtraining, the adrenals enters a state of exhaustion (Golland 1999b) and the horse is more prone to damage as the healing power after exercise is weakend . High levels of adrenaline give hyperreactivity, stressful behavoir and nervousness.

What is the possible relation between these physiological findings and rollkur?

Rollkur/ hyperflexion is a *more extreme way* of training than anything else in the riding tradition, regardless of riding style. The rollkur- training is likely meant to elicit some “advantages” in the biomechanical sphere, ie more extreme front-end movements. The possible consequences of rollkur is only studied scarcely, with respect to stress- response, but one study concluded that

“This study measured stress by using **heart rate variability analysis** for 30 min postfeeding in the morning and 30 min postexercise after a morning training session. The study found no significant difference at rest between the REC and DRES horses. During the posttraining measurements, however, the DRES horses showed, among others, a less sympathetic and increased parasympathetic dominance. These results suggest that DRES horses tend to have less acute stress than do REC horses postexercise. The findings of this study suggest maintaining the health and well-being of DRES horses despite nonnatural, biomechanical positions (van Breda 2006) “.

Using heart rate variability as a measure of the balance between sympathetic (stress) and parasympathetic (calming down) activity is a common, easy and cheap measure to use. However, measuring **after** rollkur, is likely to capture the time-window, when the horse is still high on endorphins or even tired. Also a grand prix horse is a trained athlete, and as such expected to have a faster heart rate recovery (Hada 2006)., than a less trained horse, so the two groups of horses in the study might not have been entirely comparable **A better way of studying this would be repeated measures of both endorphin and cortisol levels, of which the last can be done on saliva, ie non-invasive.**

Sloet van Oldriutenborgh-Oosterbaan did a cross-over test on 8 riding school horses in either rollkur (by draw reins, but less than is often seen with competition riders) or in free- form with light rein-contact. The test itself was for only a few minutes in trot and canter, NOT resembling the practical use of rollkur by dressage-competition riders during warm up or morning training. Despite the short duration, the heart rate and the bloodplasma concentration was higher during rollkur, **indicating a higher workload.** Acid-alkaline status measured as pH, was higher in the horses when ridden free- form, lower in rollkur, **indicating an acidifying effect of rollkur** (Sloet van Oldriutenborgh-Oosterbaan 2006).

On the basis of these studies and their implications, I am worried about the effect of rollkur/hyperflexion for the welfare of the horse, summarized as the following hypothesis:

Horses are moving with laborious/ heavier breathing, specially in canter and collected work, indicating suboptimal oxygen supply, less carbondioxide exchange. The possible effects are:

- * Endorphins have a painkilling effect, so the horse can be trained harder, without protesting or experiencing obvious discomfort or pain.
- * A horse showing conflict behavior, despite under influence of higher levels of endorphins, is really telling something about compromised welfare. Rollkur ridden horses often show conflict behavior in different situation, but the technique is forcing submission onto the horse.
- * Working with high levels of endorphins might mask minor damages to the horse.
- *Beta-endorphin is able to create a mood of euphoria and the horses might become “training addicts”, but on the basis of a brain-chemistry reaction forced on by the rider (by draw reins and hard use of bits and spurs) - not a true development of collaboration between two living beings

- * Morphine medications and endorphins is strictly forbidden according to the doping-rules and rollkur might be a way of creating an “endogenous doping” – the horse itself, **by the extreme training**, creating high levels of powerful, **medically active** beta-endorphin??
- * This could (partially) explain the hyper- reactivity also observed in many rollkur ridden horses: Conflict behavior during prize-giving ceremonies as a consequence of withdrawal, irritability and mood swings due to fluctuating levels of endorphines??
- * The horse could work as regularly chemically/medically dependent “sport-tool” for the rider, induced in its own body, by the extreme training method ??
Easier to control, than it would otherwise be??
- Is this the kind of collaboration riders want with their horse- partner for the sake of the sport ???
- * Possible blood- doping effect when rollkur is used over a time-span
- * Possible long-term effect on the neck-ligament (Weiler 1997)
- * Ethical problem in letting the horse undertake hard work, deprived of one of the major senses, the vision.....might make the horse more over-sensitive with respect to other sensory stimuli and reacting out-of-control in certain situations, like prize-giving-ceremonies.
- * Ethical problem in having the horse in a “straitjacket” under training, both physically (by the bit, draw-reins etc) and chemically, induced by the training method and lasting much longer than the training session itself.

Independent research is strongly needed to address these complex issues for the welfare of the horse and if dressage as a sport is to have a future, so that one of the fundamental FEI – rules will be fulfilled.

Riding have to improve

"The harmonious development of the physique and ability of the horse".

References

Aurich JE, Dobrinski I, Petersen A, Grunert E, Rausch WD, Chan WW. **Influence of labor and neonatal hypoxia on sympathoadrenal activation and methionine enkephalin release in calves.** *Am J Vet Res.* 1993 Aug;54(8):1333-8.

Dunbar JC, Lu H. **Proopiomelanocortin (POMC) products in the central regulation of sympathetic and cardiovascular dynamics: studies on melanocortin and opioid interactions.** *Peptides.* 2000 Feb;21(2):211-7.

Fontana F, Bernardi P, Pich EM, Boschi S, De Iasio R, Spampinato S, Grossi G. **Opioid peptide modulation of circulatory and endocrine response to mental stress in humans.** *Peptides.* 1997;18(2):169-75.

Golland LC, Evans DL, Stone GM, Tyler-McGowan CM, Hodgson DR, Rose RJ. **Maximal exercise transiently disrupts hormonal secretory patterns in standardbred geldings.** *Equine Vet J Suppl.* 1999 Jul;30:581-5. (a)

Golland LC, Evans DL, Stone GM, Tyler-McGowan CM, Hodgson DR, Rose RJ. **Plasma cortisol and beta-endorphin concentrations in trained and over-trained standardbred racehorses.** *Pflugers Arch.* 1999 Dec;439(1-2):11-7. (b)

Hada T, Ohmura H, Mukai K, Eto D, Takahashi T, Hiraga A. **Utilisation of the time constant calculated from heart rate recovery after exercise for evaluation of autonomic activity in horses.** *Equine Vet J Suppl.* 2006 Aug;(36):141-5.

Hamra JG, Kamerling SG, Wolfsheimer KJ, Bagwell CA. **Diurnal variation in plasma ir-beta-endorphin levels and experimental pain thresholds in the horse.** *Life Sci.* 1993;53(2):121-9.

Introini-Collison IB, Ford L, McGaugh JL. **Memory impairment induced by intraamygdala beta-endorphin is mediated by noradrenergic influences.** *Neurobiol Learn Mem.* 1995 Mar;63(2):200-5

Izquierdo I, Souza DO, Carrasco MA, Dias RD, Perry ML, Eisinger S, Elisabetsky E, Vendite DA. **Beta-endorphin causes retrograde amnesia and is released from the rat brain by various forms of training and stimulation.** *Psychopharmacology (Berl).* 1980;70(2):173-7.

Kokkonen UM, Pösö AR, Hyypä S, Huttunen P, Leppäluoto J. **Exercise-induced changes in atrial peptides in relation to neuroendocrine responses and fluid balance in the horse.** *J Vet Med A Physiol Pathol Clin Med.* 2002 Apr;49(3):144-50.

Mehl ML, Sarkar DK, Schott HC 2nd, Brown JA, Sampson SN, Bayly WM. **Equine plasma beta-endorphin concentrations are affected by exercise intensity and time of day.** *Equine Vet J Suppl.* 1999 Jul;30:567-9.

Mehl ML, Schott HC 2nd, Sarkar DK, Bayly WM. **Effects of exercise intensity and duration on plasma beta-endorphin concentrations in horses.** *Am J Vet Res.* 2000 Aug;61(8):969-73.

Melrose PA, Knigge KM. **Comparative topography of the immunoreactive alpha-melanocyte-stimulating hormone neuronal systems in the brains of horses and rats.** *Brain Behav Evol.* 1988;32(4):226-35.

Odberg FO, Bouissou MF. **The development of equestrianism from the baroque period to the present day and its consequences for the welfare of horses.** *Equine Vet J Suppl.* 1999 Apr;(28):26-30.

[Report of the FEI Veterinary and Dressage Committees' Workshop. The use of over bending \("Rollkur"\) in FEI Competition. FEI 2006.](#)

Rose CE Jr, Latham LB, Brashers VL, Rose KY, Sandridge MP, Carey RM, Althaus JS, Miller ED Jr. **Hypoxemia and hypercapnia in conscious dogs: opioid modulation of catecholamines.** *Am J Physiol.* 1988 Jan;254(1 Pt 2):H72-80.

Schwarz L, Kindermann W. **Changes in beta-endorphin levels in response to aerobic and anaerobic exercise.** *Sports Med.* 1992 Jan;13(1):25-36.

Soverchia L, Mosconi G, Ruggeri B, Ballarini P, Catone G, Degl'Innocenti S, Nabissi M, Polzonetti-Magni AM. **Proopiomelanocortin gene expression and beta-endorphin localization in the pituitary, testis, and epididymis of stallion.** *Mol Reprod Dev.* 2006 Jan;73(1):1-8.

Taylor DV, Boyajian JG, James N, Woods D, Chicz-Demet A, Wilson AF, Sandman CA. **Acidosis stimulates beta-endorphin release during exercise.** *J Appl Physiol.* 1994 Oct;77(4):1913-8.

Terenius L. **From opiate pharmacology to opioid peptide physiology.** *Ups J Med Sci.* 2000;105(1):1-15.

van Breda E. **A nonnatural head-neck position (Rollkur) during training results in less acute stress in elite, trained, dressage horses.** *J Appl Anim Welf Sci.* 2006;9(1):59-64.

Weiler, Horst. 1997. **/Zur Diagnostik der Insertionsdesmopathie des Funiculus nuchae an der Squama occipitalis/*.** In: Deutsche Reiterliche Vereinigung (Hrsg.): *Diagnostics in horses.* Warendorf: FN-Verlag, 106-108. Part II: Pathomorphology.

Williams RJ, Marlin DJ, Smith N, Harris RC, Haresign W, Davies Morel MC. **Effects of cool and hot humid environmental conditions on neuroendocrine responses of horses to treadmill exercise.** *Vet J.* 2002 Jul;164(1):54-63.