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The effect of pulsed electromagnetic field therapy on surface temperature of horses' backs

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received August 10, 2013
accepted January 23, 2014

Keywords: Physiotherapy, Rehabilitation, Orthopaedics, Horses.

Schlüsselwörter: Physiotherapie, Rehabilitation, Orthopädie, Pferde.

Summary

Pulsed electromagnetic field (PEMF) therapy has been proposed to decrease back pain, enhance flexibility and improve the blood circulation of back muscles in horses. This study uses thermography to address whether PEMF therapy changes the surface temperature of horses' backs. In a double-blinded cross-over study, 20 polo ponies in regular training and competition were treated randomly with 50 µT PEMF-blankets or placebo blankets applied to their backs 40 min daily for ten consecutive days. Thermograms of the back were taken on the first and the last day of each period of therapy, immediately before and within 30 min of removal of the blankets (intraday course). Single thermograms were also taken each day immediately after the therapy. The mean temperatures of different regions of the horses' backs were evaluated. Immediately after removal of the blanket (PEMF or placebo) the mean temperature was 0.69 K higher than before treatment, although there were no significant differences between PEMF and placebo intervention. There was no measurable effect of 50 µT PEMF on the surface temperature of horses' backs, although both kinds of blanket led to an increased surface temperature.

Zusammenfassung

Die Wirkung von pulsierender Magnetfeldtherapie auf die Oberflächentemperatur des Pferderückens

Einleitung

In verschiedenen Studien wird berichtet, dass pulsierende Magnetfeldtherapie (PEMF) am Pferderücken Rückenschmerzen verringert, die Rückenflexibilität verbessert und die Blutzirkulation in der Rückenmuskulatur verstärkt. In der vorliegenden Studie wird die Wirkung der PEMF-Therapie auf die Durchblutung der Rückenmuskulatur an Hand der Oberflächentemperatur mittels Thermographie untersucht.

Material und Methode

In einer doppelt verblindeten Crossover-Studie wurden 20 Polo-Ponys, die in regulärer Trainings- und Wettkampfkondition waren, sowohl mittels 50 µT PEMF Decken als auch Placebo-Decken auf dem Rücken in der Sattellage behandelt. Je zehn aufeinanderfolgende Tage wurden die Pferde 40 min pro Tag zufällig erst mit PEMF oder mit Placebo und in einer zweiten Periode umgekehrt behandelt. Thermogramme der Rückenregion wurden am ersten und letzten Tag von jeder Therapieperiode direkt vor und während 30 min nach der Entfernung der Decken durchgeführt (Tagesverlauf). Weiters wurden einzelne Thermogramme jeden Tag direkt nach der Entfernung der Decken angefertigt (Behandlungsverlauf). Die mittleren Oberflächentemperaturen verschiedener Rückenregionen wurden auf Veränderungen während des Tages- und Behandlungsverlaufes untersucht.

Ergebnisse

Direkt nach der Entfernung der Magnetfelddecken (PEMF und Placebo) war die mittlere Oberflächentemperatur um 0,69 K höher als vor der Behandlung. Allerdings waren weder im Tagesverlauf noch im Behandlungsverlauf signifikante Unterschiede zwischen der Magnetfeldbehandlung und der Placebobehandlung nachweisbar.

Schlussfolgerung

Es konnte keine signifikante Wirkung von 50 µT PEMF Therapie auf die Oberflächentemperatur von Pferderücken nachgewiesen werden, allerdings führten beide Decken, aktive oder Placebo-Decken, zu einer Erhöhung der Oberflächentemperatur der Pferderücken.

Introduction

Although magnetic field therapy is widely used throughout the world for the physical therapy of sports horses, its therapeutic effect is frequently a matter of debate. In the sixteenth century, the Swiss physician Paracelsus used magnets in the treatment of epilepsy, diarrhoea and bleeding (RAMEY, 1999). Today, pulsed magnetic fields (PEMFs) and static magnetic fields (SMFs) are applied in the treatment of horses with inflammatory and degenerative musculoskeletal disorders (PIEBER et al., 2007).

Several scientific studies have proposed that magnetic fields affect the microcirculation of the body regions to which they are applied. MAYROVITZ and LARSEN (1992) used Laser Doppler Flowmetry to demonstrate an increase in skin blood perfusion in human arms exposed to PEMF and WEBER et al. (2004) showed that PEMF therapy can stimulate angiogenesis in groin composite flaps of rats. YEN-PATTON et al. (1988) reported an enhancement in the rate of growth of endothelial cell monolayers and a reorganization of passaged endothelial cells into vessel-like structures due to the presence of PEMFs. Furthermore, TEPPER et al. (2004) established that PEMF augments angiogenesis by stimulating the endothelial release of FGF-2.

In contrast, SCHUHFRIED et al. (2005) determined that neither low-dose nor high-dose pulsed low-frequency magnetic fields alter the cutaneous microcirculation. Similarly, COLLIER et al. (1985) proved that PEMF therapy does not change the isotope uptake in the equine skeletal system by increasing the blood perfusion.

The study was performed to determine whether a 50 µT PEMF therapeutic blanket has an influence on the surface temperature of horses' backs. Diagnostic tools such as laser Doppler flowmetry (MAYROVITZ et al., 2001; MCKAY et al., 2010), laser Doppler imaging (MAYROVITZ et al., 2001) and microphotoelectric plethysmography (OKANO et al., 1999) have previously used to evaluate the effectiveness of magnetic fields. In the present study, thermography was chosen to evaluate changes in the surface temperature of PEMF-treated horses' backs. An increase in tissue perfusion has been associated with an elevated temperature of the overlying skin (LOVE, 1980). Whereas inflammatory processes are visible as regions of increased temperature (‚hot spots'), severe oedemata and swellings appear as regions of decreased temperature (‚cold spots').

The study addressed the hypothesis that 50 µT PEMF therapy leads to an increase in surface temperature due to enhanced circulation of blood in the underlying back muscles.

Material and Methods

Horses

The study used 20 Argentinian polo ponies (a mix of Criollo and Thoroughbred), mean age 10.1 years (SD 3.4 years), comprising five geldings and 15 mares with a mean height of the withers of 1.53 m (SD 0.04 m). No horse was out of work or received veterinary care due to acute back pain or lameness. All ponies were kept in private stables in Niederösterreich and were ridden using an identical programme, so that their backs were exposed to a uniform strain. The programme consisted of two one-hour training periods six days per week. Each session included a warm-up phase of 15 min of walking, followed by trot and canter for 30 min and another 15 min of walking to cool down. Training matches replaced the regular training two or three times a week. Two tournaments, in which all ponies competed, took place during the study.

Study design

Prior to the start of the study the protocol was approved by the ethics commission of the University of Veterinary Medicine Vienna.

A randomized, double-blinded, cross-over field study with 50 µT PEMF blankets and placebo control was performed, consisting of two ten-day therapy periods. The horses were randomly assigned into two groups. Blankets were applied over the saddle-region of the backs for 40 min daily after the training session (Fig. 1).

Fig. 1: Pulsed electromagnetic field blanket positioned on a horse.

One group (Group A: ten horses) received blankets with an active control device during the first ten days and placebo blankets during the second period, with a break of five to 14 days between the two periods of treatment. In the other group (Group B: ten horses), the order of the treatments was reversed. During the entire study period the functionality of the blankets was blinded to the examiners and the trainers.

Thermograms of the back of each horse were taken on the first day and on the last day of each period of therapy, immediately prior to blanket application and every 5 min for 30 min after removal of the blankets (intraday course). To monitor the course of the intervention, single thermograms were taken each day immediately after the intervention (therapy course). To ensure constant conditions, all thermograms were taken with the horses standing in their boxes, enabling the effects of direct solar radiation and wind to be minimized.

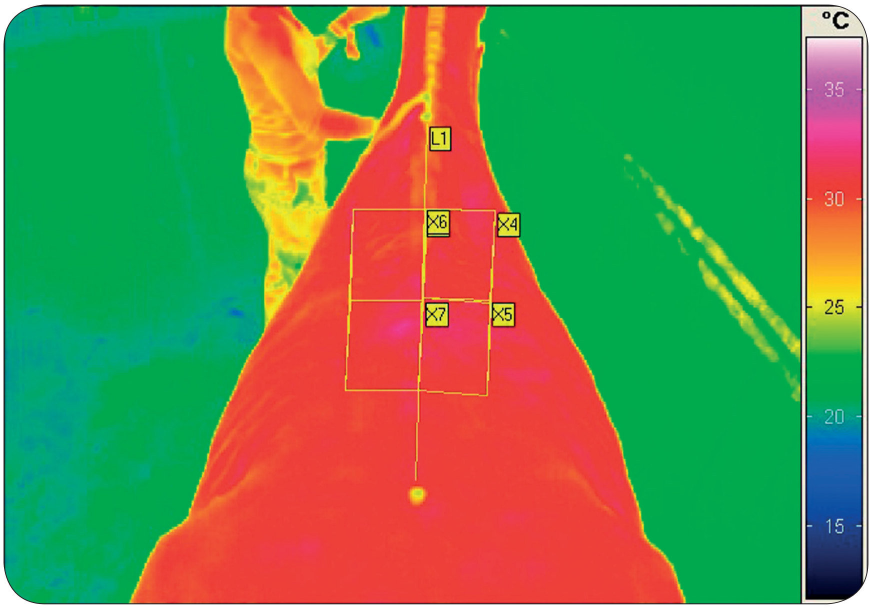

Fig. 2: Thermogram demonstrating the distribution of skin-surface temperature (°C) of a horse back with drawn rectangles (X2=X4+X5, X3=X6+X7) before applying the blankets.

PEMF- blankets

For the study, eight identical blankets (Compact-Set, Equimag GmbH, Steinau, Germany) were used, of which four were active and four non-active. Each was connected to a control device that contained the generator for the PEMF. The PEMF and placebo blankets were not distinguishable as the control panel showed the same order of programs. The PEMF blankets had a flow density of approximately 50 µT and were utilized with 100% intensity throughout the therapy. A custom-made program, using frequency bundles featuring frequencies ranging from 1 Hz to 30 Hz, was applied in each session throughout the study. The duration and frequencies of the program are listed in Table 1.

Tab. 1: Parameters of treatment with therapeutic pulsed electromagnetic field blankets

Program	Frequency	Application time
P1: Basic	2 Hz. 7.8 Hz. 4 Hz.	20 min
P2: Vitality	6 Hz. 30 Hz. 7.8 Hz. 10 Hz.	12 min
P3: Relaxation	12 Hz. 20 Hz. 15.3 Hz. 1 Hz.	8 min

Thermography

The thermographic camera (VarioCam, InfraTec GmbH, Dresden, Germany) used for capturing the distribution of the surface temperature measures emitted infrared radiation within a spectrum of 7.5 to 14 µm and has a temperature resolution of 0.08 K. The camera contains an uncooled microbolometer focal plane array with a resolution of 320x320 pixels and a 12.5 mm lens. The thermograms were taken at a distance of 1 to 2 m from the horse, keeping a vertical angle of approximately 45° between the camera and the horse's spine.

Analysis of the thermograms

The thermograms were analysed with the software program IRBIS 3 plus (InfraTec GmbH, Dresden, Germany). Two styrodur pieces were placed as reference points on the highest point of the withers and over the lumbosacral foramen of each horse and a line (‚L1') drawn between them. Two rectangles were charted on the right (‚X2') and left (‚X3') of L1 with a length of 50% and a width of 20% of L1. Each rectangles was divided into two smaller, equal rectangles, so X2 consisted of ‚X4' and ‚X5' and X3 consisted of ‚X6' and ‚X7' (Fig. 2).

The mean temperatures of X2-X7 were calculated and transferred into a spreadsheet program (Excel 2010, Microsoft Office 2010).

Statistical analysis

Mean and standard deviation were determined. Intraday effects and therapy course effects were compared using multivariate analysis of variance

(SPSS, IBM Deutschland GmbH, Ehningen, Germany). The mean temperatures were calculated only for those horses with complete picture sequences (intraday course: n=14 horses, therapy course: n=13 horses). Values of $p<0.05$ were considered statistically significant.

Results

The intraday thermograms of 14 horses showed a similar course of back temperature for PEMF and placebo interventions. Immediately after removal of the blankets the temperature was 0.69 K higher than before the application and the temperature did not decline during the subsequent 30 min. There was no significant difference between the surface temperatures of the horses' backs on the first and the last day of the periods of therapy (Fig. 3).

During the ten days of treatment, there were no significant differences between the back temperatures of horses treated with active and with placebo blankets (Fig. 4). This conclusion was found for each of the six regions.

Discussion

The results of the study do not support the hypothesis that 50 µT PEMFs lead to an increase in surface temperature when applied to horses' backs.

After removing the blankets, the average temperature was increased by 0.69 K and it did not return to the initial level within 30 min. There was no statistically significant difference between the PEMF and placebo control. The increase in surface temperature of the skin is likely to result from the covering with the blanket and not from the PEMF itself.

The study was performed under constant conditions, with the blankets applied every morning after the training sessions. The thermograms were taken in the boxes, excluding any influence of direct solar radiation and wind. Due to the study design (randomized, double-blinded, cross-over field study with placebo control), the influence of environmental conditions and training modalities can be neglected.

Although the study does not support the idea that 50 µT PEMF has an effect on the microvascular system, the field is currently beset by controversial findings. While ROLAND et al. (2000) reported a significant increase in neovascularisation in PEMF-treated rats (10 µT and 200 µT), COLLIER et al. (1985) showed that neither a 3 mT nor a 9.9 mT PEMF increased the uptake of technetium into the metacarpal bone of horses and concluded that 3 and 9.9 mT PEMF had no measurable effect on the blood circulation of the equine distal limbs. Using scintigraphy, KOBLUK et al. (1994) demonstrated that a 60 mT SMF has a stimulatory effect on blood flow, whereas STEYN et al. (2000) performed a similar study with a 27 mT SMF and found no differences between SMF- and placebo-treated animals. In view of the contradictory outcomes of the studies, the large differences between the flux densities described and the possible confounding

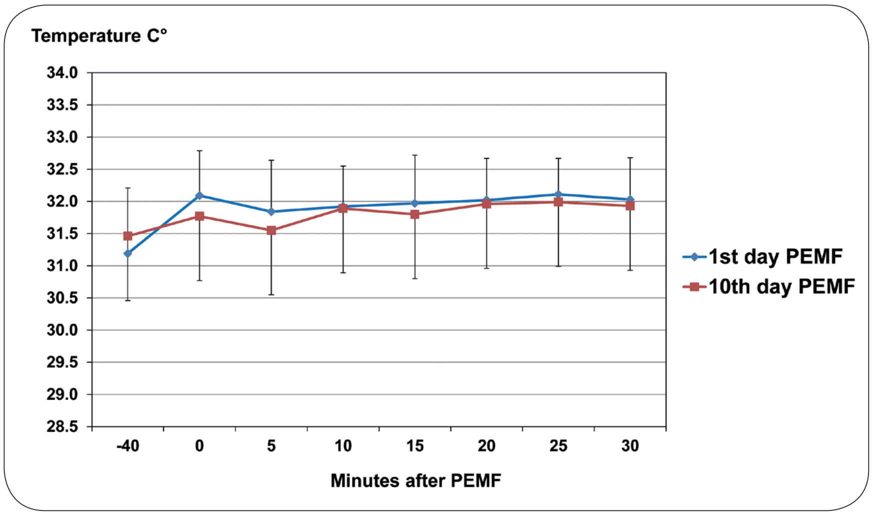

Fig. 3: Intraday course (n=14) of the mean skin surface temperature (°C) of the horse backs in region X2 on the first and last day of PEMF therapy (PEMF = pulsed electromagnetic field)

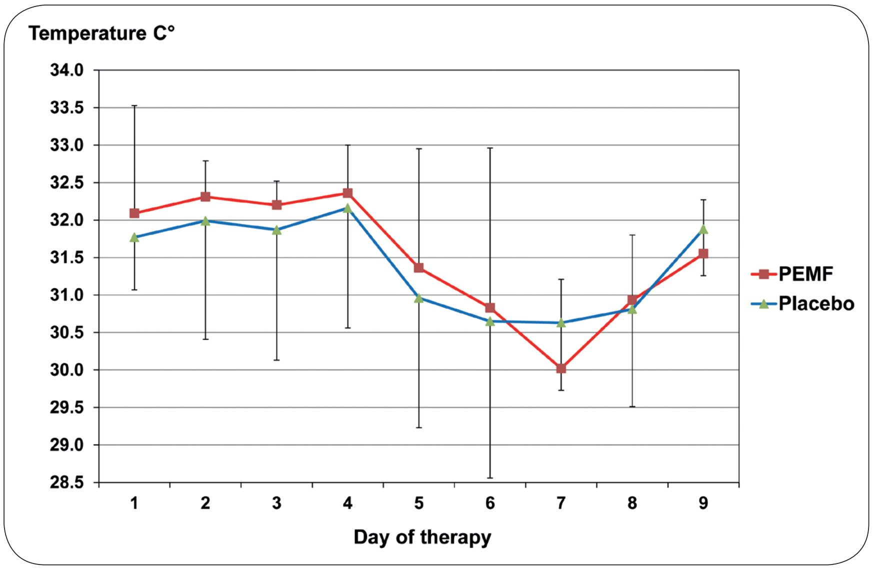

Fig. 4: Therapy course (n=13) of the mean surface temperature (°C) of the skin of the horses' backs in region X2 after removing the blankets (PEMF = pulsed electromagnetic field)

effects of natural magnetic fields such as that of the earth (100 µT), variations in flux density and time of application of the magnetic fields may be significant in determining the effectiveness of PEMF. Further investigations are required to evaluate which flow densities and application times influence the microvascular system.

Another point to consider is the correlation between muscle perfusion and surface temperature of the skin. LOVE (1980) confirmed that increased tissue perfusion leads to a rise in temperature of the overlying skin. He used various formulas derived from the laws of thermodynamics to show that surface temperature of the skin is related to the blood flow in the underlying tissues. Even though thermography is a reliable method to assess changes in temperature in structures underlying the skin (LOVE, 1980), the present study did not reveal any effect of 50 µT PEMFs on the surface temperature of horses' backs, indicating that the blood flow of the underlying tissues was not affected.

It can be concluded that there is no difference in average surface temperature between the backs of horses treated with active PEMF blankets and those of horses treated with placebo blankets. However, applying blankets to the horses' backs caused a general increase in temperature of the back surface.

Acknowledgments
The authors thank Dr. Alexander Tichy for statistical assistance as well as the Poloclub Schloss Ebreichsdorf for providing the horses.

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