





Ion Transfer as a Co-Adjuvant to Acupuncture for Treatment of Inflammatory Injuries in Horses

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Abstract

Equine spinal lesions are a common occurrence. These lesions are often caused by excessive use of certain spinal regions resulting in tissue injury that releases K⁺, Na⁺, and Ca⁺⁺ ions, in addition to allopathic substances that are present during inflammation. Several therapies are available for treating spinal lesions, including acupuncture which has been highlighted as a safe and positive technique. Of the techniques developed in Japan, ionic pumping may be a suitable co-adjuvant to the dry needling technique, offering the benefit of being less invasive. The purpose of this study was to evaluate the action of dry acupuncture and ionic pumping by diode wire

in horses with vertebral column inflammation. Twenty-three sports horses with inflammatory changes in the thoracic spine region were evaluated. This study confirmed that both the ionic pumping technique by diode wire as well as dry needling were adequate in regulating the homeostasis of the studied region. After one week of dry acupuncture (p=0.0006) and ionic pumping, the local temperature of the injury reduced significantly, allowing the inflammatory state to subside from moderate to mild to absent (p=0.001).

Keywords: Acupuncture, athletic horse, bioelectricity, inflammation

Introduction

The study on safe therapies that promote recovery in a fast and satisfactory way allowing the patient better quality of life is fundamental for the advancement of medical practice related to horses. As for equine sport, this research is even more important, since the healthy animal is able to maximize its athletic potential.

In horses, conditions that often and directly influence their quality of life and performance are those related to the spine. In a study by Martin et al. (2016), it was reported that the pressure applied by the saddle and rider on the horses' spine was considerable and can be directly related to spinal injuries. For Merriam (1997), horses of various riding modalities, especially for the purposes of training, often work with back pain. These cases of back pain are due to training with repetitive movements, con-

tributing to the development of inflammatory lesions such as defects, arthritis, myositis and other disorders of the spine.

In these cases, it is hoped that therapies will be developed in addition to nonsteroidal anti-inflammatory drugs, which will cure or improve the degree of injury, since physical activity may be the cause of the disease. Among the forms of therapy, acupuncture has been highlighted as a safe and successful technique, the use of which is allowed in large competitions (Xie et al., 1996; Xie et al., 2001). Many studies at peripheral, medullary and supraspinal levels using animal models of inflammatory pain have already been conducted evaluating the effect and mechanism of action of acupuncture (Cantwell, 2010; Habacher et al., 2006; Schweinitz, 1998; Shmalberg et al., 2014; Su et al., 2012).

Although Traditional Chinese medicine (TCM) is the most explored, Traditional Japanese Medicine (TJM) has been attracting

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a great deal of attention by presenting itself more pleasantly, with superficial stimuli, and use of fewer acupuncture needles in addition to the association of other techniques results. Over many years, these characteristics have been based on TCM and have been influenced by culture, interpretation and the search for better results and better acceptance by Japanese and Western society (Fratkin, 1999).

Among the techniques developed in Japan, ionic pumping was first described by a Japanese acupuncturist physician named Yoshio Manaka (Manaka et al., 1995). Based on the observation of human patients with burns during World War II, Manaka suggested that potassium (K^+) ion concentration in the lesion region due to cell destruction was one of the factors responsible for pain and delayed healing. Based on this idea, a simple technique was developed using a wire capable of transferring ions in one direction. This wire, variously called semiconductor wire or diode wire, is made of copper or silver. One end is attached to a small piece of diode, a material that allows the unidirectional flow of electric current forming part of a circuit (Manaka et al., 1995).

The purpose of this therapy applied by Manaka, is to transfer electrons from one area of normal tissue to another where it will have excess of potassium ion for the balance of charges to occur. Later, Manaka adapted the technique for the use associated with acupuncture points, known to have greater electrical conductivity, as well as application in other injuries caused by trauma or injury, with release of sodium ions (Na^+), calcium (Ca^{++}) and other algogenic substances in addition to potassium ion, responsible for nociceptive stimuli (Manaka et al., 1995).

Since then, there have been few scientific studies which have attempted to look into these techniques. With the aim of raising awareness of less invasive techniques that improve the forms of treatment of inflammatory lesions affecting sports horses, the objective of this study was to evaluate the use of acupuncture associated with ionic pumping and acupuncture by dry needling in inflammatory changes in the thoracic spine of horses.

Materials and Methods

Experimental design

This study was approved by the Ethics Committee on Animal Use (CEUA) of the Institute of Biological Sciences of the University of Brasília (protocol 160100/2013).

In the first stage, 23 athletic horses presenting clinical signs (palpation pain and positive for dorsiflexion test) and thermographic signs (relevant local temperature increase) of inflammation along the thoracic spine were selected from jumping and dressage disciplines. The images that presented heterogeneous heat distribution were considered relevant, in these cases, the central temperature of the hot spot (SP1) was measured and then compared with the temperature of the caudal region of the inflamed area (neutral point-SP2) (Figure 1). As proposed

by (Basile et al., 2010; Çetinkaya and Demirutku, 2012; Schweinitz, 1999), a temperature difference greater than $1^{\circ}C$ was characterized as relevant alteration.

Exclusion criteria were scars in the dorsal region, use of systemic and topical medications and presence of tricotomy in the dorsal region. No animals were exercised during the 3 h prior to the thermographic evaluation. During the clinical examination, it was observed that the internal body temperature was within the normal range for equine species, with an average of $37.05 \pm 0.9^{\circ}C$. The clinical examination was performed at room temperature from 19 to $29^{\circ}C$ as suggested by Turner (2007).

The 23 equines were separated into 3 groups:

Acupuncture group by dry needling (GA): Animals treated with acupuncture by dry needling (n=6);

Ionic pumping group (GB): Animals treated with acupuncture associated with the ionic pumping technique (n=11);

Control group (GC): Animals with inflammatory disorder, but not treated (n=6).

In order to observe the inflammation prior to the proposed treatments, a thermographic examination was used to indicate the increase in surface temperature, a pathognomonic characteristic finding of an acute inflammation (Schweinitz, 1998). The evaluations took place in two stages, as follows:

M0 – initial stage before any therapeutic intervention;

MF – second stage after one week of the dry acupuncture session or that associated with the ionic pumping technique.

The animals of the GC group were evaluated in both the M0 stage and in the stage that corresponded to the MF.

Thermographic evaluation

For thermographic evaluation, the animals were kept in their stalls, exposed to normal resting conditions and protected from the sun, rain or drafts. To obtain the images, the thermographic apparatus (Flir® model E49001/E40; FLIR Systems Australia Pty Ltd, Melbourne, Australia) was positioned at a distance of one and a half meters from the animal in the upper position, so that the field of view was approximately 45 degrees and emissivity equal to 0.98. Such characteristics were adopted in all evaluations. To obtain the data, the central temperature of the pre-diagnosed abnormal focus (Sp1 region) was checked three times to obtain a mean (ΔT_a) (Figure 1). In the same way, the temperature of the region of the caudal vertebral column was measured at the abnormal focus (Sp2) with absence of thermographic abnormality, obtaining the value used as self-control (ΔT_n) (Figure 1).

In this way, we neutralized the influence of the variation of the ambient temperature in the evaluated moments, since the ef-

fects of the external environment were equal for the two foci. After obtaining these data, the thermal differential (ΔT : $\Delta T_a - \Delta T_n$), which is the temperature difference between the mean of the abnormal focus (ΔT_a) and the mean of the normal focus (ΔT_n), was calculated. The ΔT was the final data to be evaluated. This methodology was similar to that performed by Um et al. (2005).

To evaluate the clinical significance of the thermographic findings, the inflammation was characterized according to the degree of temperature recorded by the thermographic analysis before (M0) and after (MF) treatment, namely, absent, mild, moderate and severe. These parameters were determined in accordance with several authors (Çetinkaya and Demirutku, 2012; Holmes et al., 2003; Schweinitz, 1999; Turner, 2007). Thus, the following criteria were adopted:

ΔT up to 0.5°C were considered normal, therefore, they were absent from inflammatory alterations;

ΔT between 0.5 and 1.5°C were considered as mild inflammatory grade;

ΔT between 1.5 and 2.5°C were considered as moderate inflammatory grade;

ΔT above 2.5°C were considered as severe inflammatory grade.

Acupuncture treatment

After the thermographic evaluation in M0 of all the animals, treatment with acupuncture by dry needling (GA group) and acupuncture using the ionic pumping technique (GB group) was started.

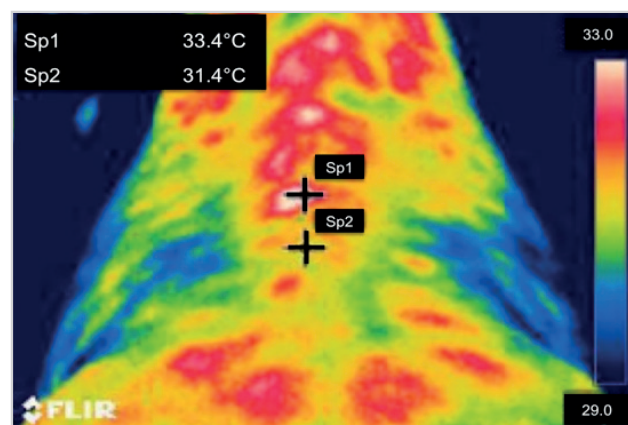


Figure 1. Thermographic image of the thoracolumbar spine of an equine in sports training, in relation to the initial evaluation (M0). Thermographic image of the initial moment with intersection (Sp1) indicating a point temperature of 33.4°C in an infrared light with significant change and intersection (Sp2) at a point temperature of 31.4°C in an unchanged infrared light.

In the GA group, the selection of acupuncture points was based on the technique of Lun Huan Chiao Ti Fa. This technique, almost always referred to as “closing the dragon,” consists of circling an area using points around the perimeter of the inflammation, including bladder meridian (paravertebral) and governing vessel (dorsal midline in intervertebral spaces). Other points such as special and mastery points related to spinal injuries were used, namely: B-40, B-60, VG-20, VB-27, BP13, B-23, VG-3, VG-4, B-52 (Altman, 2006). All points were stimulated using only $0.25\text{mm} \times 30\text{mm}$ acupuncture needles inserted into the subcutaneous tissue and held for 20 min. A total of 15 needles were used in the treatment of GA.

In the technique used in the GB group only three acupuncture needles were used. The first one was inserted guided by thermography into the center of the inflammation, and at that point a acupuncture needle of size $0,18\text{mm} \times 25\text{mm}$ was inserted superficially. Two other needles were inserted into the bilateral paravertebral region at the time of the third lumbar vertebra (corresponding to acupuncture point B-23). Diode wire was attached to all needles using the positive pole in the inflamed region and the negative pole in the lumbar region. In this way, the transfer of ions occurs from the inflamed region to the neutral region. This technique was applied for 20 min.

At the end of treatment, the number of animals (%) that presented homeostasis (the thermal equilibrium between the inflamed and non-inflamed area) was quantified.

Statistical analysis

At the end of the data collection, the results obtained were statistically analyzed using GraphPad Prism® software version 6.0 for Windows (GraphPad Software, San Diego, CA, USA). All data were submitted to descriptive analysis to obtain the mean and standard deviation of the mean. Then, the Kolmogorov-Smirnov normality test was applied to then submit the data to Student's t-paired test between the two corresponding moments (M0xMF) of each group (GA, GB, GC) and one-way ANOVA among GA, GB, GC groups. The $p \leq 0.05$ was adopted for all treatments as statistically significant.

Result and Discussion

The GA group showed a 48% ($p=0.0006$) in the temperature variation in the focus of the lesion measured in M0 (1.68 ± 0.39) compared to MF ($0.81 \pm 0.4^\circ\text{C}$) (Figure 2). The GB group showed a 53% ($p=0.0001$) decrease in the temperature variation in the focus of the lesion measured in M0 (1.09 ± 0.08) compared to MF ($0.58 \pm 0.1^\circ\text{C}$). In the GC group, no change in temperature ($p > 0.05$) was observed between the times M0 ($2.03 \pm 0.9^\circ\text{C}$) and MF ($2.05 \pm 0.91^\circ\text{C}$) (Table 1).

In GA, it was observed that, after treatment with dry needling, in five of the six individuals, the degree of inflammation went

from moderate to absent, which was considered to be clinically irrelevant. In GB, clinical recovery was also obtained in nine of eleven individuals. In contrast to what was observed in the GA and GC groups, in the GC group the degree of inflammation was not altered, remaining moderate in MF (Table 1) (Figures 1 and 2).

The observed effect was evident in the GA and GB groups, where ΔT was considerably reduced. The data obtained in this study contributed to other findings of authors who also affirmed the action of acupuncture versus the sympathetic division of the autonomic nervous system, promoting an active action on vasomotor tone concomitant to the inflammatory response (Schweinitz, 1998; Schweinitz, 1999; Scognamiglio-Szabó and Bechara, 2001).

More precisely, Huang et al. (2013) reported that acupoint stimulation acted locally on receptors in complex structures such as nerves, blood vessels, and lymphatics. Acupuncture ex-

erts a stimulus that triggers the production of neuropeptides, processing and integration of cytokines and causes the nerve impulses to be sent through the peripheral and autonomic nervous system, thus generating a precise and complete regulation of the neuropeptide chain, for example the cytokines, which acted directly in the process of inflammation (Fu et al., 2007; Huang et al., 2013).

According to the degree of change in heat distribution, the final result of GA and GB showed complete resolution of the initial vasomotor change. These results suggest restoration of the process of inflammation, since the ΔT was below 0.5°C in several animals, being considered clinically irrelevant (Basile et al., 2010; Schweinitz, 1999). For M2, the effects of acupuncture were sufficient to reduce the change from moderate to mild which may represent an important clinical improvement. In contrast to the treated groups, GC did not show any significant results at the end of the experiment, and ΔT was not observed below 1°C , which led to the belief that the disorder was maintained.

As cited by Parmen et al. (2014), local acupuncture applied to spinal diseases may decrease local edema, inflammation, vasodilation or vasoconstriction, release of histamine or kinins. These signs were stronger in severe and moderate changes, which may have made it possible to more clearly visualize the local repair effects of acupuncture. On the other hand, mild alterations, for the most part, may be those with chronic characteristics caused by the high physical requirements and functionality of the spine in performing repetitive exercises. In addition, the mechanical action of the rider, or rider and mount equipment, regardless of discipline, must be considered, since these act continuously along the thoracic and lumbar vertebral column. According to Schweinitz (1998), many of these cases can become incurable unless the animals end their athletic life, as the cause of the injury will constantly be present. However, the results of our study suggest that acupuncture is effective in restoring spinal vasomotor alterations in horses with training routine and with active participation in competitions, since it is able to significantly reduce or eliminate the degree of the alteration observed in the study.

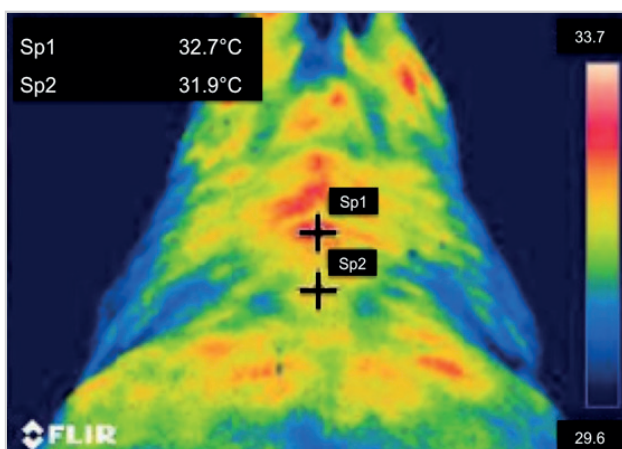


Figure 2. Thermographic images of the thoracolumbar spine of an equine in sports training, after the acupuncture session in association with ionic pumping (MF). Thermographic image with intersections indicating the focal point temperature initially with a relevant change (Sp1) of 32.7°C and that of unchanged focus (Sp2) of 31.9°C after one week of the associated acupuncture session to ionic pumping.

Table 1. Representation (mean and standard deviation) of the results obtained in the thermographic evaluation of acupuncture groups by dry needling (GA) and ionic pumping (GB), and control group (GC)

	GA (n=6)	GB (n=11)	GC (n=6)
M0	1.68±0.39	1.09±0.08	2.03±0.9
MF	0.81±0.4	0.58±0.1	2.05±0.91
M0-MF	0.87±0.01 ^a	0.51±0.02 ^b	0.02±0.03 ^c
Homeostasis (%)	83.3	81.8	0.0
Inflammatory grade in M0 / MF	Moderate / absent	Light / absent	Moderate / Moderate

M0: Initial moment; MF: Final moment, M0-MF: Thermal difference between MF and M0; Homeostasis (%): percentage of cases where homeostasis was achieved.

^{a,b,c} Different superscripts within the same line indicate significant difference among groups $p \leq 0.05$.

Conclusion

Acupuncture actively influences the disorders that lead to vasomotor alteration of the spine of horses. This treatment significantly reduced the problems in the present study. Both acupuncture by dry needling and acupuncture associated with the ionic pump clinically reestablished the homeostasis of the studied region, something that was not observed in the control group. The thermographic examination is adequate to detect vasomotor alterations in the thoracolumbar region of the spine and to monitor the response obtained by acupuncture treatment.

Ethics Committee Approval: Ethics Committee Approval was received for this study from the Ethics Committee of the Institute of Biological Sciences of the University of Brasília (protocol 160100/2013).

Peer-review: Externally peer-reviewed.

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Conflict of Interest: The authors have no conflict of interest to declare.

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