

# Effect of Therapeutic Magnetic Wraps on Circulation in the Third Metacarpal Region

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Static magnetic pads with an average field strength of approximately 350 G at the level of the magnet do not affect the circulation to the equine third metacarpal region. Authors' addresses: P.O. Box 5231, Glendale, CA 91221 (Ramey); Dept. of Radiological Health Sciences, Veterinary Teaching Hospital, Colorado State University, Fort Collins, CO 80523 (Steyn); and Division of Geological & Planetary Sciences, California Institute of Technology 170-25, Pasadena, CA 91125 (Kirschvink). © 1998 AAEP.

## 1. Introduction

One of the more popular products with which horse owners can treat their horse appears to be the wrap containing low-intensity magnets. Although the biological effects of low-level magnetic fields have been studied since the 1500's, there is no consensus as to the effects and whether, if they exist, they have any physiological significance. This randomized, controlled, double-blinded study evaluates the effect of low-intensity static magnetic pads on the perfusion of the metacarpal region in six horses.

## 2. Materials and Methods

One pair of magnetic wraps designed for the equine third metacarpal region was purchased from the manufacturer. The field strength of both pads was measured at the pad, at the level of the wrap, and at a distance of between 1 and 2 cm from the pad surface. One of the pads was demagnetized (inactive wrap), and the pads were marked A and B for later identification.

The effect of magnetic fields on the regional blood perfusion to the metacarpal region was evaluated in

six horses. *In vivo* labeling of red blood cells was performed with 75 mCi stannous pyrophosphate ( $^{99m}\text{Tc-PYP}$ ). Bilateral dorsal and lateral images of the metacarpal region of each horse were made and served as controls. Wraps were applied to each forelimb in a randomized fashion and were left in place for 48 h. After the 48 h had expired, the horse's red blood cells were again labeled by using the same technique; the wraps were then removed. Dorsal and lateral images were acquired as soon as possible after the removal of the bandages.

Quantitative scintigraphic evaluations were performed to calculate the target-to-nontarget perfusion ratios. A ratio between the mean counts per pixel of a region of interest within the magnetic field and the mean counts per pixel of a region of interest outside of the field (distal radius) was calculated. This was done for all limbs before and after treatment.

The difference between the prewrapping and postwrapping ratio values for each lateral and dorsal scan was calculated. These values were then used to evaluate the effect of wraps A and B. Values for

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each lateral and dorsal scan were evaluated separately. The Mann-Whitney test, a nonparametric test equivalent to an unpaired student's *t* test for a small number of observations, was used to test these hypotheses.

Upon completion of the study, the pads were retested for magnetic field strength and the inactive and magnetized pads were identified.

### 3. Results

The field strength of the magnetic fields at the level of both pads was approximately 450 G (gauss) at its peak, with an average field strength of approximately 350 G. At the level of the bandage (1–2 mm from the pad surface), the field strength dropped to approximately 200 G. At a distance of 1 cm from the pad, the field strength was less than or equal to 1 G.

There was no significant difference in the median values of the dorsal scans between the two wrapping methods at  $p < 0.1$ . The median relative perfusion ratio difference for wrap A on the dorsal scans was  $-0.075$ , and for wrap B it was  $-0.04$ .

There was no significant difference in the median values of the lateral scans between the two wrapping methods at  $p < 0.05$ , but there was a difference at  $p < 0.1$ . This means that if more observations had been conducted, it might have been possible to have a significant difference at  $p < 0.05$ , with the possible difference favoring pad B. The median relative perfusion ratio difference for wrap A on the lateral scans was  $-0.045$ , and for wrap B it was  $-0.125$ .

After scintigraphic testing, the pads were re-evaluated. It was revealed that pad A was magnetized. So as to prevent any possibility of incomplete demagnetization, the magnet in pad B had been replaced with a Teflon sheet by the third author, without prior knowledge of the first two authors. Teflon is inert and nonmagnetic. The field strengths of pad A were identical to those measured prior to the beginning of the study.

### 4. Discussion

Measurements of the magnetic wraps used in this study showed a rapidly decreasing field strength. Magnetic fields are measured in one of two units: 1 T (tesla) =  $10^4$  G. For reference, the existing magnetic field of the earth is 0.5 G. Thus, at approximately 1 cm from the magnetic pad surface, there was no detectable magnetic field from the pad. This would imply that there can be no effect from a wrap-produced magnetic field on tissues deeper than 1 cm from the magnet surface.

This study fails to confirm the results of another study that evaluated the effects of magnetic pads in horses by using nuclear scintigraphy.<sup>1</sup> We decided to investigate the reported effects of low-intensity static magnetic fields on the circulation to the metacarpal region because of the experimental design problems of that study. The experimental model, which compared the results of scans on one treated

limb versus the nontreated limb, is questionable, as one forelimb should not be used as a control for the other in scintigraphic studies (each limb should be used as its own control). Furthermore, a bandage and magnetic pad were applied to one limb while only a bandage was applied to the other. A more appropriate design would have been a bandage and a demagnetized pad. The radioisotope used in the previous study was  $^{99m}\text{Tc}$ -MDP, a bone-seeking radiopharmaceutical that attaches to the calcium hydroxyapatite molecule of bone. Although the amount of tracer that labels to the calcium hydroxyapatite molecule of a particular bone is, among other things, correlated to the amount of blood flow to that bone, we decided to label the red blood cells themselves. This should give a more sensitive and accurate evaluation of regional perfusion.

Quantitative scintigraphy is best performed through the calculation of regional perfusion ratios (target-to-nontarget ratios), in which the denominator of the ratio is (a) a region in the same leg and (b) not in the magnetic field. Absolute counts of a region, as performed in the previous study, are not considered an accurate comparison between limbs for the following reasons, all of which affect the number of counts or nuclear disintegrations per region: (a) the number of pixels (size of the regions) measured will invariably be different between two limbs; (b) the gamma camera can be different distances from different limbs; and (c) different amounts of radiopharmaceutical uptake are often seen in different limbs during the same scan (i.e., one entire limb can be hotter than the contralateral limb).

Numerous studies have failed to show any effect of low-intensity magnetic fields on blood circulation. No effect of dental magnets on the circulation of blood in the human cheek could be demonstrated in one study.<sup>2</sup> A study on the circulatory effects of a magnetic foil was unable to show any effect in the skin of human forearms,<sup>3</sup> and the application of a magnetic foil to healing wounds in rats apparently caused no significant effects.<sup>4</sup> Another study in horses showed that the application of a magnetic pad over the tendon region for 24 h caused no evidence of temperature increase in treated limbs versus placebo-controlled limbs, using thermographic measurements as an indirect assessment of blood circulation to the area.<sup>5</sup>

Studies commissioned by the makers of one type of magnetic pad showed that exposure of a highly concentrated saline solution in a glass capillary tube increased the flow of the solution. Although the mechanism for the increase in saline flow is not apparent, it certainly could not have been related to any dilatory effect on the walls of the glass capillary tube. The investigator who performed the study has stated that the results of the experiments performed using highly concentrated saline in a glass tube should not be extrapolated to effects that would be expected with flowing blood.<sup>6</sup>

If a magnet did cause local increases in circulation,

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one would expect the area under the magnet to feel warm or become red as a result. Although it would be difficult to detect in horses, such an effect is not reported when magnets are held in the human hand. Furthermore, one would expect any circulatory effects produced by very weak magnetic fields to be magnified in stronger magnetic fields. However, no circulatory effects have been reported in magnetic resonance imaging machines, in which the magnetic forces generated are 2–4 orders of magnitude greater than those produced by therapeutic magnetic pads. In studies in which humans were exposed to magnetic fields of up to 1 T, there was no evidence of alterations in local blood flow at the skin of the thumb or at the forearm.<sup>7</sup> Even a 10-T magnetic field is predicted to change the vascular pressure in a model of human vasculature by less than 0.2%, and experimental results of the effects of strong magnetic fields on concentrated saline solutions are in general agreement with these predictions.<sup>8</sup>

### 5. Conclusions

From the results of this study, one may conclude that there is no effect of low-intensity static magnetic fields on blood circulation to the equine third metacarpal region. Even if there were an increase in

circulation, that might not equate to a beneficial physiologic effect.

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