

ASSESSMENT OF THE SHORT-TERM EFFECTS OF A PERMANENT MAGNET ON NORMAL SKIN BLOOD CIRCULATION VIA LASER-DOPPLER FLOWMETRY

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Background: Little scientific evidence supports the frequent claims that permanent magnets, with surface field strength in the range of most commercially available "therapeutic" magnets or systems, significantly alter human blood circulation. Some recent scientific findings suggest an absence of circulatory effects. Thus, there is a need to provide more sound, scientifically based information on this issue. This study tests for magnet-related skin microcirculation effects.

Methods: In 12 healthy volunteers (35–60 years, 6 male) a 1000-gauss surface field disk-shaped magnet was placed overlying muscle, near the lateral epicondyle of the humerus on one arm, and a sham (zero-gauss) magnet was placed in the corresponding position on the other arm. Skin blood perfusion (SBF) and the speed (U) and volume concentration (V) of moving red blood cells were measured simultaneously, adjacent to each device, prior to magnet placement and for 30 minutes after placement, with a dual-channel laser-Doppler measuring system. Average SBF, U and V, preexposure and during the initial and final 5-minute exposure intervals, were determined and compared.

Results: No significant magnet-related changes were found in any of the 3 measured indices of skin blood flow (SBF, U or V), either at sham or active magnet sites.

Conclusions: These findings do not support the notion that permanent magnets produce magnet-related change in blood flow in normal individuals with normal circulation in the region of magnet application. Tests in situations of abnormal circulation are currently underway.

INTRODUCTION

WHILE REPORTS ON THE USE OF LODESTONES, THE predecessor of modern-day permanent magnets, for pain relief^{1–5} or other salubrious effects, extend

into antiquity, there are significant gaps in the scientific evidence for their efficacy and near voids in explanations of any possible mechanisms of action. One consistently proposed mechanism is a possible enhancing effect of permanent magnets on blood circulation. Some evidence has been reported that pulsed electromagnetic fields in the 27 MHz range may increase skin blood perfusion,^{6,7} and a few reports have suggested some direct effect of static magnetic fields on blood vessels in experimental situations.^{8,9} Other reports have not demonstrated magnet-related changes in blood circulation.^{10,11}

In this study, we sought to determine if a magnet, having a field strength in the range of those used in many magnets marketed for magnetic therapy, would increase skin blood perfusion as measured by laser-Doppler methods.

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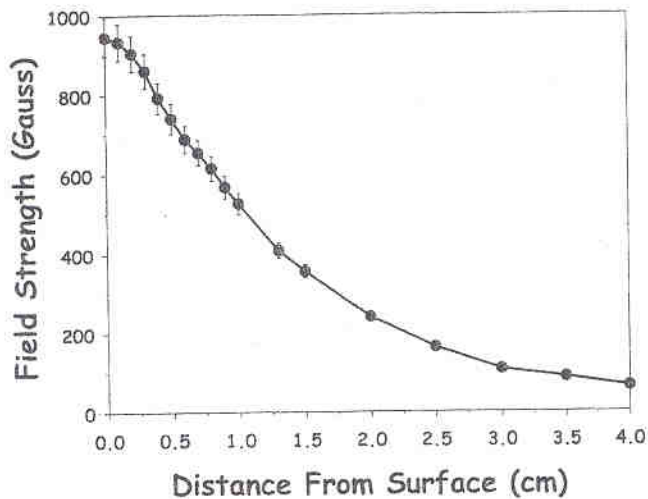


Figure 1. Magnetic-field intensity as a function of the distance from the magnet surface.

MATERIALS AND METHODS

Subjects

Healthy volunteers (N = 12, age 35–60, 6 male) drawn from the staff of a medical center participated after signing an institutional review board–approved informed-consent statement. No subjects had previously used any form of magnetic therapy nor were any taking vasoactive medications.

Magnets

Commercially available (Magnetherapy, Riviera Beach, FL) disk-shaped ceramic magnets (4 × 1 cm) with a 1000-gauss surface field (Fig. 1) and weighing 68 g were used. Devices identical in appearance and weight, but without a magnetic field, were used as shams. The magnetic field strength at the magnet's center, on its surface, and at various distances above the surface was verified with a Gaussmeter (Walker Scientific, model MG-3AB) and transverse Hall-effect probe (model HP-13R), which has a sensing area of 4 mm² and a stated accuracy of 1%. Figure 1 shows the field variation as a function of the vertical distance above the center of the magnet.

Skin Blood Perfusion

Skin blood perfusion (SBF) was measured using the laser-Doppler method, a recognized method for measuring skin blood circulation.^{12–14} It is based on the principle that laser light that penetrates the skin interacts

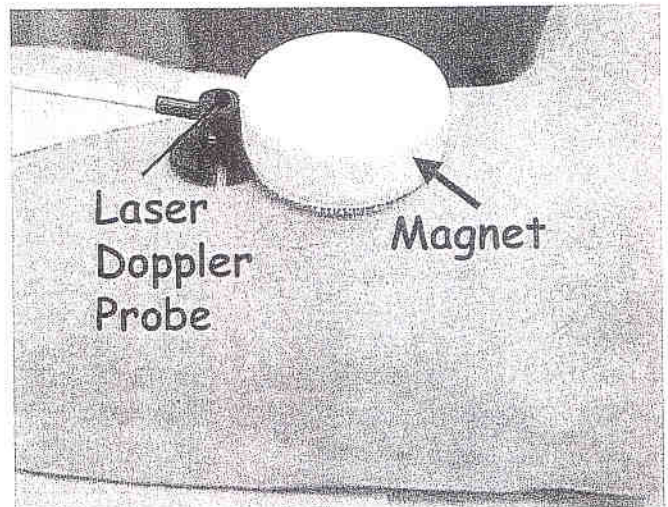


Figure 2. Magnet and laser-Doppler probe placement.

with moving red blood cells, and that this interaction causes a Doppler shift in the frequency of the laser light. The Doppler-shifted, reflected light energy is an index of skin blood flow.

Procedure

Subjects rested quietly, supine, on a standard examination table for 15 minutes. Thereafter a laser-Doppler probe, connected to a dual-channel laser-Doppler system (Moor Instruments, model DRT4) was gently taped to each arm. Preexposure laser-Doppler data were recorded for 5 minutes, after which an active magnet and a sham were placed immediately adjacent (proximal) to each probe (Fig. 2). The magnet and sham were placed overlying the supinator and hand extensor muscles, 4 cm distal to the lateral epicondyle of the humerus. Laser-Doppler measurements were made less than 0.5 cm from the magnet edge. The calculated average pressure exerted by the magnet weight is 4.0 mm Hg, a pressure level that has little if any effect on underlying blood flow. The magnet and sham were left in place for 30 minutes, during which laser-Doppler data were monitored and recorded on a computer. The magnet and sham pair were previously selected by an individual without contact with the experimental team. Neither subjects nor the investigator who placed the magnet knew which was the magnet until after the experiment. An investigator was present with the subject during the procedure. A second investigator, who was blinded as to which device was the magnet, analyzed the data.

Laser-Doppler Results Prior to Exposure and During Initial and Final 5 Minutes of Magnet and Sham Exposure

	Preexposure Interval		Magnet and Sham Exposure Intervals			
	Magnet	Sham	Initial 5 minutes		Final 5 minutes	
			Magnet	Sham	Magnet	Sham
Perfusion	23.2 ± 3.4	23.8 ± 4.1	24.0 ± 3.1	24.4 ± 4.4	21.7 ± 3.5	22.5 ± 4.5
Velocity	43.6 ± 6.5*	22.4 ± 3.9	45.8 ± 7.1*	23.4 ± 4.4	41.5 ± 7.3*	23.8 ± 4.3
Volume	23.6 ± 0.7*	48.2 ± 2.3	24.7 ± 0.8*	49.1 ± 2.5	24.2 ± 0.6*	44.6 ± 2.1

Values are mean ± sem and are expressed in arbitrary units. No significant changes in perfusion, velocity or volume attributable to magnet effects were detected

*designates differences ($p < 0.01$) between active and sham arm sites. Note that these differences were present prior to exposure and during each exposure interval.

Analysis

The average laser-Doppler skin blood perfusion (Q), red blood cell velocity (U), and volume concentration of moving red blood cells (V) in the preexposure interval (interval A), during the initial 5-minute exposure interval (minute 0–5, interval B), and during the final 5-minutes of exposure (minute 25–30, interval C) were determined offline via computer processing. To statistically test for possible sequential effects, Q, U, and V at magnet and sham sites were individually tested using Friedman's nonparametric test for k-related samples ($k = 3$). Possible differences between magnet and sham sites were assessed for each interval using the Mann-Whitney test. In all statistical tests, a level of $p \leq 0.05$ was considered significant.

RESULTS

The main laser-Doppler numerical results are summarized in the table.

Blood Perfusion Differences between Arms

There was no significant difference in blood perfusion between arms prior to magnet or sham exposure or during the initial or final 5-minute exposure intervals. However, individual components of perfusion, blood velocity, and volume concentration differed between arms, with the active magnet target site having a higher velocity and lower volume concentration than the sham

target site. These differences were present prior to exposure and remained unchanged during the initial and final 5 minutes of exposure. Thus, these initial differences are judged to reflect normal spatial variability in the perfusion components at the initially chosen skin sites.^{14–16}

Sequential Blood Perfusion Changes

None of the three laser-Doppler parameters—perfusion, velocity, or volume concentration—changed significantly from preexposure interval through final exposure interval at either sham or active magnet exposed sites.

DISCUSSION

This work tested the hypothesis that static magnetic fields, as produced by a standard therapeutic permanent magnet in the 1000-gauss range, produce a short-term effect on human skin blood flow in the region of their application. The anatomical site chosen for this study was a skin area overlying skeletal muscle, since many reported applications of such therapy are targeted toward muscle conditions. The results, however, provide no evidence of a magnet-related effect on skin blood circulation in the healthy subjects studied. This was clearly demonstrated by the absence of any significant change in any of the skin blood flow indices at the site of magnet application. This finding is consistent with previous work, which showed no short-term effect of permanent magnets on the skin blood circulation of the hand or fingers.¹⁰ However, it is important to note that since the bi-

ological target of the magnetic field and the specific field strength and configuration needed to interact with it are unknown,¹⁷ these negative results do not yet rule out effects that might be present in persons with pathologically reduced or otherwise compromised circulation. The latter possibility would be consistent with the view that responses to applied magnetic fields depend in part on the amount that the target tissue or organism deviates from normality. According to this concept, magnetic-field effects may be different in healthy persons as compared with persons with some dysfunction or injury in the target tissue.¹⁸

However, it is unknown if there is an underlying blood circulation deficit associated with the various conditions for which static magnet use has been reported as efficacious in pain reduction.¹⁻⁵ It is thus unclear if these variously reported effects are linked to a magnet-related improvement in blood circulation. It is also unclear that any effect on pain exists. Further systematic investigation of these possibilities is currently underway.

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