Clinical Rehabilitation 2002; **16**: 669–674

Comparative effect of positive and negative static magnetic fields on heart rate and blood pressure in healthy adults

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Received 13th February 2002; returned for revisions 19th March 2002; revised manuscript accepted 9th April 2002.

Objective: To compare changes in heart rate (HR) and blood pressure (BP) associated with short-term exposure to static magnetic fields (SMFs) of positive versus negative polarity.
Design: A double-blind, randomized controlled trial using a time series design.
Setting: Physical therapy laboratory in a university setting.
Subjects: Seventy-five adults with a mean age of 30.6 years were assigned to one of three treatment groups. No subjects had any symptoms of cardiovascular disease or cardiac irregularity.
Interventions: Fifteen-minute exposure to an SMF by lying on a mattress pad containing magnets of positive polarity, negative polarity, or none (placebo).
Main outcome measures: HR and BP were monitored prior to exposure, at 1-minute, 5-minute, 10-minute and 15-minute intervals following exposure, and again 5 minutes after exposure.
Results: Subjects in all groups demonstrated slight decreases in HR and BP, but none of these changes were associated with the intervention ($p = 0.170$).
Conclusions: Short-term exposure to an SMF of either positive or negative polarity does not appear to cause any clinically meaningful changes in HR or BP among asymptomatic subjects. This finding supports the safe use of unipolar SMFs that contain low-intensity magnets (<1000 gauss) relative to the cardiovascular system.

Introduction

The therapeutic use of magnets dates back to ancient times when the Greeks, Egyptians and Chinese all recorded healing powers associated with the earth's magnetic field.[1] Modern interest in the analgesic and energizing effects of magnets has produced worldwide sales of magnetic products in excess of $5 billion.[2] Because magnets are gaining popularity with the general public, additional research is needed to determine their efficacy and safety as a clinical modality.

Many of the health benefits of magnets have been associated with the polarity of the static magnetic field (SMF). Each magnet has a negative and positive pole that are believed to produce opposite physiological effects. Therapeutic

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10.1191/0269215502cr538oa

devices in which all the magnets are oriented in the same direction are referred to as *unipolar* SMFs, whereas devices containing magnets arranged in alternating directions are referred to as *bipolar* SMFs. Several books written on magnetic therapy indicate that exposure to a negative SMF produces calming, healing effects by relieving pain, reducing oedema, increasing cellular oxygenation, promoting tissue alkalinity, eliminating free radicals and toxins, stimulating melatonin production, slowing heart rate and blood pressure, and promoting more restful sleep.[1,3–5] A positive SMF is described as producing more of a stimulating or energizing effect by accelerating cell growth and activity, increasing fluid retention, promoting tissue acidity, producing free radicals, and increasing metabolism, heart rate, blood pressure, brain activity and wakefulness. Thus a positive SMF may be referred to as the *stress field*, and a negative SMF may be called the *anti-stress field*.[5]

Although research on pulsed electromagnetic fields (PEMFs) has demonstrated positive effects on pain, sleep, bone and wound healing and other conditions, scientific evidence supporting the physiological and therapeutic effects of SMFs is limited.[6] Most of the research on SMFs has focused on analgesic effects, and these studies produced conflicting results.[2,7–15] More recent studies examining the effects of SMFs on tissue healing, tissue temperature and standing balance were also inconsistent.[16–18] In addition to the different conditions studied and the subjective nature of pain ratings, other factors that may account for these variable findings include differences in the type, intensity, size and polarity of the magnets used. Most investigators applied relatively weak SMFs (≤1000 gauss) that were either of negative polarity or of alternating positive and negative polarity. The only consistent finding may be the lack of adverse effects associated with the use of low-intensity SMFs. Thus, many practitioners and consumers have concluded that, although SMFs may not necessarily be beneficial, they are not likely to be harmful. Currently, the only precautions that have been issued for magnetic devices include electrical implants (i.e. cardiac pacemakers, defibrillators and insulin pumps), pregnancy (due to unknown effects) and obesity (due to poor penetration of the magnetic field). However, no controlled studies have compared the effects of negative and positive SMFs to determine whether their polarity really produces opposite physiological responses and whether these effects are significant enough to warrant precautionary use.

This study compared heart rate (HR) and blood pressure (BP) responses among healthy subjects as they rested on pads containing magnets of negative polarity, magnets of positive polarity or placebo magnets. These physiological measures were selected because Philpott[19] claims the heart is the most responsive tissue to the stress or anti-stress fields created by magnets. He states that a significant (10 point) decrease in HR will occur within a few minutes of exposure to a negative SMF, and that a positive SMF will have the opposite effect. However, he provides no data to support these observations. One study by Jehenson *et al*.[20] did report a significant increase in cardiac cycle length (i.e. decrease in HR) following exposure to a high-intensity SMF (20 000 gauss) in a magnetic resonance chamber. However, other subjects who were exposed to a weaker SMF (10 000 gauss) experienced no changes in HR or rhythm. Considering the limited information in this area, a null hypothesis was posed. In other words, any changes that occurred in HR or BP were not expected to differ between subjects who were exposed to the positive or negative SMF, nor were these changes expected to exceed an amount that would normally occur in any resting individual.

Methods

The sample included 75 healthy adults (52 women and 23 men) between the ages of 21 and 57 (mean = 30.6 years) who had no history of cardiovascular problems or cardiac irregularities. All subjects were screened for contraindications such as implanted electrical devices and pregnancy, and all signed an informed consent form. Most of the subjects (91%) had no prior experience with magnetic therapy.

Using a multigroup time-series design, subjects were randomly assigned to a treatment group that exposed them to either a negative SMF (n = 25), a positive SMF (n = 26), or a placebo SMF

($n = 24$). Both the subjects and the research assistant who was recording the measurements were blinded to the group assignment. The dependent variables included heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) which were measured six times using an automatic blood pressure monitor.

The SMF was applied using quilted pads that consisted of 100% hypoallergenic cotton fabric with a thin layer of polyester padding. Each 50 × 60 cm pad contained 42 magnets or placebo disks that were 9 mm in diameter and 2 mm thick. The magnets were made of a neodymium–iron–boron alloy and had a manufacturer's rating of 10 800 gauss each. However, a gaussmeter indicated that the actual surface strength of these magnets was only 400–500 gauss each. The polarity of the magnets was determined by another assistant using a compass; the negative pole of each magnet was identified as the side that attracted the north-seeking needle of the compass and vice versa. The individual magnets in each pad were loosely stitched into placed so they could be easily turned to face in the same direction (i.e. toward the negative or positive pole). Thus, one pad was identified as the positive pad and one was identified as the negative pad prior to subject assignment and monitoring. Neither pad was folded or allowed to come in contact with the other pad to avoid any attraction between magnets that might alter the orientation or strength of the magnetic field.

Subjects were placed in a semi-reclining, supine position and the blood pressure cuff was applied over the right brachial artery. A baseline measure was recorded after a 10-minute rest period. Subjects were then asked to roll onto their side while another assistant placed one of the pads on the table where it would rest under their thorax. Following application of the magnetic or placebo pad, HR and BP measures were repeated after 1 minute, 5 minutes, 10 minutes and 15 minutes. The pad was then removed and the last measurement was taken 5 minutes later. Subjects listened to an audiotape of soft instrumental music and natural sounds throughout the treatment session to minimize distraction from any environmental noise.

Data were analysed with a repeated measures, multivariate analysis of variance (RM-MANOVA) to compare changes in the dependent variables over time and across the three treatment groups (interaction effect). Post-hoc univariate analyses were used to independently compare the changes that occurred in HR, SBP and DBP. Pairwise comparisons were used to determine whether significant changes occurred between specific measures. A second RM-MANOVA of measures one through four (i.e. baseline, 1 minute, 5 minutes and 10 minutes post-application) was also run to test Philpott's claim that cardiovascular changes would occur within the first few minutes of exposure. All data were analysed at the 0.05 alpha level using SPSS statistical software.

Results

The comparative changes in HR, DBP and SBP are presented in Table 1. Results of the RM-MANOVA (Table 2) revealed no statistically significant differences among the groups across these six measures (Wilks' lambda = 1.290, p = 0.170, power = 0.925). When the analysis was limited to measures that occurred during the first 10 minutes after the pad was applied (Table 2), a statistically significant difference was found among the groups (Wilks' lambda = 1.776, p = 0.035, power = 0.942). The univariate analyses suggested that the greatest amount of change occurred in the BP readings. However, none of the groups consistently demonstrated more change than the others. When comparing the changes between sequential measures, the greatest change in HR occurred during the first minute of exposure among subjects in the positive SMF group (mean = –2.4 bpm); this was accompanied by a slight decline in BP as well (mean SBP = –1.4 mmHg). However, the greatest fluctuations in BP occurred in the negative SMF group where SBP rose an average of 1.6 mmHg during the first minute and then decreased by 2.5 mmHg over the next 5 minutes. When analysing the changes that occurred during the initial 10 minutes of exposure *within* all subjects regardless of group assignment (Table 2), a significant decrease was found in all three variables (Wilks' lambda = 2.274, p = 0.028, power = 0.863).

Discussion

The multivariate and univariate analyses support the hypothesis that the changes in HR and BP that occurred in these subjects did not differ in relation to the type of pad on which they lay, and none of these changes were more than one might expect to find in a normal individual at rest. All subjects experienced a slight reduction in both HR and BP that was most likely due to a general relaxation response. However, the small amount of change that occurred within subjects may also be attributed to measurement error because most of these changes fell within the 2% accuracy range of the automatic BP cuff used in this study. Thus, these findings do not support Philpott's assertion that exposure to a positive SMF will immediately increase a normal person's HR by 10 bpm, while a negative SMF will gradually slow the HR by the same amount.[19] According to these data, the HR and BP of subjects in the SMF groups actually responded in the opposite man-

Table 1 Sequential changes in HR, SBP and DBP in each group

Dependent variable	(+) Polarity group (*n* = 26) Mean (SD)	(–) Polarity group (*n* = 25) Mean (SD)	Placebo group (*n* = 24) Mean (SD)
Heart rate (bpm)			
Pre-application	71.2 (13.9)	67.8 (11.4)	64.7 (11.8)
1 min post application	68.8 (13.7)	67.6 (11.6)	63.6 (11.9)
5 min post application	69.7 (13.7)	66.9 (11.3)	63.3 (10.2)
10 min post application	70.4 (12.6)	66.5 (11.8)	62.1 (10.5)
15 min post application	70.0 (13.0)	67.3 (11.1)	63.5 (10.9)
5 min post removal	70.5 (13.4)	67.6 (11.6)	64.0 (10.6)
Systolic BP (mmHg)			
Pre-application	120.3 (13.2)	117.7 (11.8)	115.5 (9.3)
1 min post application	118.9 (13.4)	119.3 (12.6)	115.1 (9.5)
5 min post application	119.7 (12.3)	116.8 (11.7)	115.0 (10.1)
10 min post application	117.7 (12.1)	116.0 (10.1)	114.8 (9.7)
15 min post application	118.2 (12.4)	117.2 (11.8)	114.5 (9.6)
5 min post removal	119.7 (13.2)	117.0 (11.5)	113.6 (9.1)
Diastolic BP (mmHg)			
Pre-application	75.2 (10.3)	71.3 (9.8)	73.2 (7.0)
1 min post application	73.9 (10.0)	73.0 (10.5)	72.0 (7.8)
5 min post application	73.9 (9.9)	71.9 (9.3)	72.1 (7.3)
10 min post application	73.5 (9.6)	71.5 (9.4)	71.1 (7.7)
15 min post application	74.0 (9.7)	72.1 (8.3)	72.5 (7.1)
5 min post removal	74.2 (10.1)	72.6 (8.5)	71.6 (7.2)

Table 2 Results of multivariate and univariate analyses comparing changes between and within groups

Type of comparison	Multivariate		Heart rate		Systolic BP		Diastolic BP	
	F	*p*	*F*	*p*	*F*	*p*	*F*	*p*
Between groups across all measures	1.290	0.170	0.748	0.679	1.538	0.124	1.333	0.211
Between groups – first 10 min only	1.776	0.035	1.520	0.173	1.885	0.085	1.984	0.069
Within subjects across all measures	2.274	0.028	3.869	0.010	4.254	0.006	2.972	0.033

Clinical messages

- No short-term changes were found in heart rate or blood pressure that could be associated with lying on magnetic mattress pads of either positive or negative polarity.
- This study provides no evidence to support the suggested reduction of cardiovascular stress via exposure to a static magnetic field.

ner during the first minute of exposure. However, none of these changes were large enough to be considered clinically meaningful. Some of the fluctuations observed during the first few measures may also have been associated with a startle response that several subjects demonstrated when the blood pressure cuff began to inflate automatically.

Overall, these results suggest that healthy people who lie on either positive or negative magnetic pads experience no significant deviations in their HR or BP. These findings are consistent with those of Jehenson *et al.*[20] who reported no significant changes in cardiac rhythm among subjects who were exposed to an SMF of 10 000 gauss (compared to changes that did occur at twice that intensity). This seems to imply that low-intensity SMFs, such as those provided by most magnetic mattress pads, are unlikely to affect the cardiovascular system. However, these results cannot be generalized to patients who have known cardiac conditions such as arrythmias or hypertension. In addition, these findings are based on a single, short-term use of magnetic pads that were only applied to one portion of the body. Repeated exposure to an SMF by sleeping on a magnetic mattress pad on a continual basis could produce different effects. Because the pads were placed underneath subjects' backs instead of directly over their chest area, the distance between the magnets and the target organ (i.e. the heart) may also have been too great to cause an effect. In reality, people frequently change their body position during sleep, and these position changes are likely to affect the relative strength of the magnetic exposure.

Conclusions

This study provides the first controlled comparison of unipolar SMFs of differing polarity. These findings did not support popular assertions that SMFs of opposite polarities, when placed near the heart, would produce opposite physiological responses. Minor fluctuations that occurred in subjects' HR and BP were comparable to those observed in control subjects and were most likely associated with general relaxation. Although these findings seem to support the safe use of low-intensity SMFs, further studies are needed to determine whether the use of more intense SMFs for longer duration have the same level of safety. Additional research is also needed to determine whether other postulated polarity effects associated with magnetic therapy are valid, particularly those related to the pain management and tissue repair.

Acknowledgements

The author would like to thank Omar Palomin, Ryan Sanders and Kathy Reyes for their assistance with data collection and Karri Lynn Smith, Vice President of *Relieve Pain Today* in Marietta, Georgia for providing the magnetic and placebo pads that were used in this study.

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