Original Article

THE EFFECT OF MAGNETIC FIELD ON THE BIOCHEMICAL PARAMETERS OF MICE BLOOD

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SUMMARY: The effect of different types of poles of magnets north/north (N/N), south/south (S/S), north/south (N/S) and south/north (S/N), magnet strength 2mT, for 3 and 6 days were monitored on the biochemical parameters of male Swiss Albino mice blood. Comparing to unexposed mice, significant variations in biochemical parameters (cholesterol, triglyceride, glucose and total protein) were noticed. Each type of poles have their own effect which totally different than the others. It is concluded that the effect seen with electromagnetic fields were due to magnetic filed in general. The effect of magnetic field on animals should be studied further in a step to evaluate them as a possible approach of managing patients with disorders related to glucose and lipids metabolism.

KEY WORDS: Swiss Albino mice, cholesterol, triglyceride, glucose and total protein.

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INTRODUCTION

Individuals with occupational exposures to static fields including operators of magnetic resonance imaging (MRI) units, personnel in specialized physics and biomedical facilities (for example, those working with particle accelerators) and workers involved in electrolytic processes such as aluminum production. Some aluminum-manufacturing workers are reported to be exposed to fields of 5-15 mT for long periods of time, with maximum exposures up to 60mT[1, 2], another study reports average fields of only 2-4 mT[3]. Workers in plants using electrolytic cells are reported to be exposed to fields of 4-10 mT for long periods of time, with maximum exposures up to 30 mT.[4,5] Individuals working with particle accelerators are exposed to fields above 0.5 mT during their working hours, with intermittent exposures to fields above 300 mT and maximum exposures of up to 2,000 mT[6].

Another source of exposure to static magnetic fields is the residual fields that can remain after strong static magnets are removed. For example, after a clinical MRI unit is removed from a room, a residual field of as high as 2 mT may remain from steel in the structure that has been permanently magnetized. Such fields are not sufficiently strong to be a concern for human health, but they may be strong enough to interfere with the operation of sensitive electronic

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equipment. These residual fields can be reduced (although not always eliminated) by professional "degaussing".

The aim of this work is to evaluate the effect of magnetic field alone as high as 2 mT, arranged in various sets of polarity on the biochemical profile of mice blood.

SCIENTIFIC METHODS

Experimental Animals

A total of 60 Male Swiss Albino mice were used as the study model, those are further divided into 5 sets. Each set is made of 12 mice, i.e.: control group, and 4 other sets each is corresponding to a particular polarity combination i.e.: (+/+), (-/-), (+/-) and (-/+).

Experimental Design

Different types of poles of magnet (N/N, N/S, S/S and S/N) were used to monitor the hematological parameters of the mice under study. Magnets were attached on the side of mice head (N/N), (N/S), (S/S) and (S/N) using superglue after shaving, where the pole (N=north) or (S=south) were the one attached directly to the head of the animal, the strength of magnet was 2 mT.

Exposure times were studied first to determine the maximum effect relative to time. Meanwhile, control animals were used in this study to monitor any changes in the parameters under study. Same size and weight of magnet but of an inert material (paper cartoon) were used and were attached on the head of the animals to have a control result. Each trial was repeated at least 3 times to have significant values.

Biochemical assay

Biochemical parameters (cholesterol, triglycerides, glucose and total protein) were measured by the use of an automated system (Boehringer Mannheim Hitachi Spectrophotometer, model 4020).

Statistical Analysis

The data collected were entered into a personal computer and analyses of data were performed using SPSS statistical package. T-test was used for comparing means. P value were considered to be statistically significant if < 0.05.[7]

RESULTS

Determinations of Biochemical's Parameters

Cholesterol (CHOL)

The mean level of cholesterol from the serum of unexposed mice was 119 mg/dl, (100%). After exposing the mice to the magnet effect of different poles for three and six days, respectively, the value for +\+ was decreased by 13% and increased by 8%, respectively. When the exposed mice were exposed to -\-, the value was increased by 8% and 7%, respectively. However, after exposing the mice to +\- and -\+ for 3 and six days, separately, the value obtained was increased by 18% and 12%, 32% and 18%, respectively (Tables I and II). It is evident that the magnet poles -/+ is associated with the highest change in cholesterol level.

Triglyceride (TG)

The mean of triglyceride from the serum of control mice was 167 mg/dl (100%). After exposing the mice to magnet poles for three and six days, the value for +\+ poles was decreased by 14% and increased by 8%, respectively. When the mice were exposed to -\- poles, the value was decreased by 47% and 31%, respectively. However, after exposing the mice to +\- and -\+ for 3 and 6 days, separately, the value obtained was decreased by 59% and 6%, 55% and 36%, respectively (Tables I,II). The magnet poles: -\- and -\+ were the most influential on the triglyceride level.

Glucose (GLU)

The mean of glucose of the serum from

control mice was 266 mg/dl (100%). After exposing the mice to magnet poles for three and six days, respectively, the value of +\+ poles was increased by 5% and decreased by 27%, respectively. When mice were exposed to -\- poles, the value was decreased by 1% and increased by 6%, respectively. However, after exposing the mice to +\- and -\+ for 3 and 6 days, separately, the value obtained were decreased by 4% and 39%, increased by 1% and 13%, respectively (Tables I, II). It seems that the magnet pole +\+ and +\- were the poles influencing the glucose level maximally.

TABLE-I

Magnetic field effect on some biochemical parameters in the blood of Swiss albino mice exposed for three days

Sample		*CHOL (mg/dl)*	*TG (mg/dl)*	*GLU (mg/dl)*	*TP (g/dl)*
Control	Mean	119	167	266	5.8
	SD	±3.2	±2	±3	±0.3
	%	100	100	100	100
+/+ 3 days	Mean	103**	143**	278**	4.6
	SD	±2	±3	±3	±0.2
	%	87	86	105	79
-\- 3 days	Mean	129**	88**	262**	6.2**
	SD	±2	±2	±4	±0.3
	%	108	53	99	107
+\- 3 days	Mean	140**	68**	254**	5.5**
	SD	±2	±3	±3	±0.4
	%	118	41	96	95
-\+ 3 days	Mean	157**	75**	269**	5.7(n.s)
	SD	±3	±3	±2	±0.2
	%	132	45	101	98

CHOL: Cholesterol; TG: Triglyceride; GLU: Glucose; TP: Total Protein

(n.s.) = Non-significant P> 0.05
* = Significant P< 0.05
** = Highly significant P< 0.01

Total Protein (TP)

The mean of total protein from the blood serum of control mice was 5.8 mg/dl (100%). After exposing the mice to magnet poles for three and six days, the value for +\+ poles was decreased by 21% and increased by 10%, respectively. When mice were exposed to -\- poles, the value was increased by 7% and 3%, respectively. However, after exposing the mice to +\- and -\+ for 3 and 6 days, separately, the value obtained was decreased by 5% and increased by 21%, decreased by 2% and 6%, respectively (Tables I, II). It is observed that the magnet poles +\+ and +\- had the most significant influence on the total protein level.

TABLE-II

Magnetic field effect on some biochemical parameters in the blood of Swiss Albino mice exposed for six days

Sample		*CHOL (mg/dl)*	*TG (mg/dl)*	*GLU (mg/dl)*	*TP (g/dl)*
Control	Mean	119	167	266	5.8
	SD	±3	±2	±3	±0.3
	%	100	100	100	100
+\+ 6 days	Mean	128**	180**	196**	6.4**
	SD	±2	±4	±2	±0.2
	%	108	108	73	110
-\- 6 days	Mean	127**	116**	281**	6**
	SD	±2	±2	±2	±0.2
	%	107	69	106	103
+\- 6 days	Mean	133**	158**	161**	7**
	SD	±3	±5	±5	±0.5
	%	112	94	61	121
-\+ 6 days	Mean	141**	107**	301**	505**
	SD	±6	±8	±7	±0.4
	%	118	64	113	94

CHOL: Cholesterol; TG: Triglyceride; GLU: Glucose; TP: Total Protein

(n.s.) = Non-significant P> 0.05
* = Significant P< 0.05
** = Highly significant P< 0.01

DISCUSSION

A few biological effects have been reported in laboratory systems for fields as low as 20 mT, and some organisms appear to be able to detect changes in the strength and/or orientation of the Earth's static magnetic field (0.03-0.05 mT)[8,9]. In addition, the rates of some chemical reactions can be affected by magnetic fields as low as 10 mT.[10,11]

There are known biological mechanisms through which strong (greater than 2000 mT) static magnetic fields could cause biological effects[8], but these mechanisms could not account for biological effects of static fields with intensities of less than 200 mT[8,12].

It is conceivable that biological effects could be mediated through effects on free radical reaction rates at field strengths as low as 0.1 mT.[10,11,13,14] but there is no evidence that such effects have any biological significance.[13,15]

All biochemical parameters studied (cholesterol, triglyceride, glucose and total protein) were affected by different poles of magnet, but it seems that the magnet poles -\+ and -\- were the poles associated with a significant influence on cholesterol and triglycerides level; whereas, the poles +\+ and +\- were the poles maximally influencing the level of glucose and total protein. It could be explained that different poles combination might be capable of producing free radicals at different reaction rates.

It is well known that, a very delicate balance exist between glucose utilization and production. This balance is maintained by the interplay between the hormones; insulin and glucagons. Moreover, serum total protein elevation are generally due either to loss of fluid from the body (dehydration) or to increase in the globulin component. These elevations can be reversed within a short time by replacement of water.[16]

The data shown here indicate a change in the glucose level in the serum of the exposed animals. This agrees well with previous findings with electromagnetic fields with different strengths.[17,18,19] The change in the total protein concentration for the exposed animals is in agreement also with the findings of the others.[17,19]

These findings could be attributed to the fact that cell membrane is a likely to be the primary site for the cascade of events resulting in biological responses. These responses could be due to different primary events such as: Changes in the diamagnetic properties of membrane phospholipids[20], variation of the induced membrane potential along the surface of the cell[21], generation of primary radicals that can form free radicals subsequently causing cell damage[22], influences on the surfaces of the macromolecule within cells[23], effects on the order in the membrane structure and charge movements which are critical for enzymatic actions[24], counter ion polarization and hence changes in the ionic environment of membrane embedded macromolecules[17,25,26,27] and most evidently the effects on the membrane-mediated Ca^{++} process.[28-30]

The careful analysis of the findings of other researchers along with these findings, particularly those concerning the lowering effect of magnets on biochemical parameters like glucose, triglyceride and cholesterol, necessitate the assessment of those magnets on human and explore their potential role in clinical application.

Patients with hypertriglyceridemia, diabetes mellitus and hypercholesterolemia are potential candidates for carefully designed and controlled studies that can meticulously assess the safety and efficacy of using this hypothetical approach as other options in alternative medicine.

An interesting part of this work was the finding of different effects due to different poles combinations; this phenomenon in our opinions deserves further studying.

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REFERENCES

1. Stuchly MA. Human exposure to static and time-varying magnetic fields. Health Phys, 1986;51:215-225.
2. NIOSH Health Hazard Evaluation Report: Alumax of South Carolina. Cent Disease Control Prevention, NIOSH, 1994.
3. Von Kaenel R et al. The determination of the exposure to electromagnetic fields in aluminum electrolysis. In: "Light Metals 1994", U Mannweiler, ed., The Minerals, Metals and Materials Society, 1994;pp 253-260.
4. Marsh JL et al. Health effect of occupational exposure to steady magnetic fields. Amer Indust Hygiene Assoc J, 1982;43:387-394.
5. Barregard L et al. Cancer among workers exposed to strong static magnetic fields (letter). Lancet October 19, 1985:892.
6. Budinger TF et al: Biological effects of static magnetic fields. In: "Proceedings of the 3rd Annual Meeting of the Society for Magnetic Resonance in Medicine", Society for Magnetic Resonance in Medicine, Berkeley 1984; pp 113-114.
7. Marija JN SPSS/PC+ for IBM PC/XT/AT. SPSS INC. Chicago. USA 1985.
8. Kowalczuk CI et al. Biological effects of exposure to non-ionizing electromagnetic fields and radiation. I. Static Electric and Magnetic Fields (NRPB-R238). Natl Radiat Protec Board 1991, Chilton.
9. Miller G. Exposure guidelines for magnetic fields. Amer Indust Hygiene Assoc J, 1987;48:957-968.
10. Schulten K. Magnetic field effects in chemistry and biology. Adv Solid State Phys, 1982;22:61-83.
11. Scaiano JC et al. Model for the rationalization of magnetic field effects in vivo. Application of the radical-pair mechanism to biological systems, Photochem Photobiol, 1994;59:585-589.
12. Repacholi MH et al. Guidelines on limits of exposure to static magnetic fields. Health Phys, 1994;66:100-106.
13. Brocklehurst B, KA McLauchlan. Free radical mechanism for the effects of environmental electromagnetic fields on biological systems. In J Rad Biol, 1996;69:3-24.
14. Eveson RW, CR Timmel et al: The effects of weak magnetic fields on radical recombination reactions in micelles. Int J Radiat Biol, 2000;76:1509-1522.
15. Mohtat N et al. Magnetic field effects on the behavior of radicals in protein and DNA environments. Photochem Photobiol, 1998;67:111-118.
16. Calbreath DF. Clinical Chemistry, a Fundamental Textbook. Saunders Company, Harcourt Brace Jovanich, Inc. (1992).
17. Fadel MA et al. Effect of low ionizing fields on biological membranes. In: Twelfth School of Biophysics of Membrane Transport, Poland 1994; May 4-13.
18. LeBars H & G Andre: Effect of electromagnetic field on pancreatic release. Rev Gen Electr 1976; (July Special issue) 91-97.
19. El-Mashak EM et al. Effect of different low-level electromagnetic fields on rats. J Fac Education, 1992;17:517-528.
20. Rosen AD. A proposed mechanism for the action of strong magnetic fields on biomembranes. Int J Neurosci, 1993;73:115-9.
21. Loew LM. Voltage-sensitive dyes. Measurement of membrane potentials induced by DC and AC electric fields. Bioelectromagnetics, 1992;1:179-89.
22. Diazani D. In: Electricity and Magnetation in biology and medicine. Blank M ed. San Francisco Press: Berkley, CA (1992).
23. Isobe A and AR Liboff: In: Interaction between EMF and cells; Chisbrera, Nicolini and Schwan ed. Plenum, London, 1994; pp282-293.
24. Hong FT. Effect of ELF on cell membranes. Proc Natl Acad Sci USA, 1994;90:1283-1285.
25. Polk C. Alternation on the cellular level of different tissues due to different electric fields. Bioelectrochemistry and Bioenergitics 1992;28:279-289.
26. Kumosani TA and EM El-Mashak. Effect of Electromagnetic field of the Na^+, K^+- ATPase level in different lobes if mice brain. Egypt J Biophys, 1995;1:41-46
27. Zhgenti TG & GSH Kenvanishvili. About the effect of a low frequency electromagnetic field on the biological cell. Biofizika 1991;36:483.
28. Blackman CF et al. Effect of ELF on calcium ion effect from brain tissue in vivo. Radiat Res 1982;92:510.
29. Blackman CF et al. Bioelectromagnetics 1988;9:215.
30. Bates MN. Extremely low frequency electromagnetic fields and cancer: The epidemiological evidence. Health Perspect, 1991;95:147-160.
31. Taneva P. Role of $Ca2^+$ in transducing ELF fields effects in cells. Biophys J, 1992;66:217-223.