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Review

A review of bioeffects of static magnetic field on rodent models

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ABSTRACT

This review is aimed to summarize the experimental researches in the influences of static magnetic field on laboratory rodent models, reported by laboratory scientists, experimental technicians, clinical surgeons, animal veterinarians, and other researchers. Past studies suggested that static magnetic field-singly applied or used combined with other physical or chemical substances-significantly relieved some pains and ameliorated certain diseases in different organ systems, e.g. hypertension, osteoporosis, neuralgia, diabetes and leukemia etc. But on the other hand, some harmful events have also been observed in a number of investigations, from cellular level to fetal development. So exposure to static magnetic field might have dual effects on experimental rodent in various environments, viz. there are potentially therapeutic benefits, as well as adverse effects from it. The positive effect may relate to moderate intensities, while negative influence seems to be in connection with acute strong static magnetic fields. In addition, different orientations of static magnetic field exert different degrees of impact. Thus, the bioeffects of static magnetic field exposure on mice/rats depend on magnetic field intensities, durations and directions, though the exactly relationship between them is still vague. Further researches need to perform with appropriate methodologies, ingenious designs repeatedly and systemically, not only in animal models, but also in human volunteers and patients.

Contents

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1. Induction

Magnetotherapy seems to be one of the most promising complementary and alternative medicines, since side-effects cannot be ignored in surgery, chemotherapy, or radiotherapy, due to invasive ways and potential harms they possessed. In fact, in ancient Chinese medicine science, lodestones were applied to cure paralysis, rheumatism, edema and headache, according to the Divine Farmer's Materia Medica and the Yellow Emperor's Canon of Internal Medicine, more than 2000 years ago.

Over the past few decades, some investigations were performed on clinical trials, referring to many disorders and diseases of humans, to assess the latent effects of static magnetic field (SMF). These reports covered various aspects of human body, including lymphatic system, cardiovascular system, nervous system etc. (Okano et al., 2006; Potenza et al., 2010; Rozanski et al., 2009; Štolfa et al., 2007; Tenuzzo et al., 2006). However, most of these investigations are conducted in cellular or molecular level, while human subjects are forbidden to employ considering moral principles in most cases, subsequently, yet the biological effects of SMF is hard to illustrate unequivocally.

Under this background, diverse experimental researches, which carried out over the years, have examined the influence of chronic/acute exposure of laboratory animals to SMF, especially mammals (Saunders, 2005), since animal models would facilitate attempts to mimic human responses to certain diseases or possible risks due to its genetic resemblance with human beings, as well as some merits like high reproduction periodically, well developed disordered models, and relative low costs.

To the best knowledge we have, experiment in the effect of SMF on rodent model was launched since 1948, though only one parameter was appraised in that research (Barnothy, 1963). Then vast studies into application of SMF in medicine have been processed, using different rodent models, drug-induced, disease suffered or tissue injured models, for example. The conclusions got by different institutions are varied, probably ascribing to the diverse exposure systems they applied. Even though a few negative results were observed, many intriguing positive phenomena were still discovered and some plausible mechanisms involved were explained wisely, which makes SMF becoming a conceivable regimen of noninvasive physicotherapeutics.

Some articles have reviewed the effect of SMF at cellular level (Dini and Abbro, 2005; Miyakoshi, 2005, 2006), in animal studies (Saunders, 2005), on epidemiological health (Feychting, 2005), and with safety evaluation (Schenck, 2000). To date, there is no summarized review regarding effects of SMF exposure on biological systems based on rodent models, although mice and rats are applied as the most ordinary models. So the primary objective of this paper is to sum up literature concerning SMF and rodent, where possible. Some studies describing effects of SMF in cellular level are also covered for mechanism elaboration.

2. Rodent models

Since animal models are fundamental tools in biomedical study, as the ones of sharing a high degree homology with humans, mice and rats are commonly used in laboratory tests for better understanding human disorders. A number of rodent disease models have been developed and improved for years, and hundreds of investigations using them were implemented in SMF effect research at different levels, e.g. whole body, histological, cellular, membrane, organelle, or even molecular level. While the model you choose can deeply impact your research outcomes, it's necessary to have some knowledge on lab mouse/rat. Here, we give brief introductions of most familiar strains, BALB/c and C57BL/6 in mouse, Wistar and Sprague–Dawley in rat. More detailed models used in SMF studies see Tables 1 and 2.

2.1. Lab mouse

Selecting appropriate genetic strain of mouse for SMF research has come true, since the inbred strains have been set up and used commonly for decades. As mammals, murine models with drug-induced diseases have been well-established, either for investigating disease pathogenesis (Baker, 1998) and probable mechanisms (Whishaw et al., 2001), or for assessing the effectiveness and poisonousness of diverse candidate instruments and drugs, physically and chemically, which facilitated human health researches.

2.1.1. BALB/c mouse

The most advanced murine strain is BALB/c mouse. As we known, BALB/c is an albino, laboratory-bred, tumor-prone strain of house mouse. It's useful for research into both cancer and immunology, and can develop reticular neoplasms, renal tumors and others, for their variability of genes and vulnerability to plasmacytomagenesis (Potter, 1985), which is an important process for production of monoclonal antibodies. There are remarkable differences between diverse BALB/c substrains (Hilgers et al., 1985), understanding the discrepancy between them can help investigators to choose suitable strains or models of mice for studies on bioeffects of SMF (Crawley et al., 1997).

2.1.2. C57BL/6 mouse

As a popular subline, C57BL/6 is a productive inbred strain of lab mouse (Peters and Festing, 1985), with characteristics of stain stability, easy breeding, and short life span. Being general multipurpose