

Effect of Whole Body Magnetic Field Exposure on the Sensori-Motor Recovery in Spinalised Rats

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Abstract

We report the effect of chronic (2h/d x 8 weeks) exposure to MF (50 Hz, 17.9µT) on the sensori-motor, autonomic functions recovery in complete spinal cord (T₁₁) transected rats. Adult male rats were divided into Sham, SCI and SCI + MF groups. BBB score, threshold of tail flick (TTF), tail flick latency (TFL) were noted to assess sensori-motor functions. In MF exposed rats, a statistically significant improvement was noted in BBB score, TTF and TFL by 2nd, 1st, 5th wk respectively and their survival rate increased. This study suggests a significant recovery in complete SCI rats by chronic MF exposure.

1. Introduction

A complete transection of spinal cord (SCI) leads to a chronic lack of sensory and motor functions below the level of injury with residual complications of pain, bowel and bladder dysfunction due to a limited intrinsic capacity of central nervous system to repair and regenerate itself. Numerous experimental intervention strategies namely; blocking astrocytes produced inhibitory molecules, implantation of peripheral nerve grafts embedded in a bFGF-containing fibrin gel, implantation of olfactory ensheathing cells, grafting embryonic spinal cord tissue, implanting trophic factor-secreting fibroblasts and electrical stimulation have been used to stimulate the intrinsic regenerative capacity of spinal cord neurons. While, electrical stimulation of peripheral nerve (1), hippocampus or spinal cord promotes functional recovery (2, 3), axonal regeneration and guidance, magnetic fields (MF) protect against ultraviolet light or severe hypoxia also (4). The beneficial effect is possibly mediated by their action amongst several others on Ca²⁺⁺ influx, nerve growth factors, serotonin turnover (5) and free oxygen radicals. Pulse electromagnetic field (PEMF) may specifically improve the quality of life in SCI patients due to better autonomic control of bladder and bowel (6, 7); increased respiratory and coughing capabilities (8); and prevention of deep vein thrombosis. Besides it also reduces a wide variety of pain in studies on humans and animals through its action on endogenous opioids (9, 10, 11, 12). Therefore, the literature suggests that PEMF promotes neurogenesis, increases 5-HT turnover, stimulates locomotor capability, and improves autonomic functions, which are compromised in SCI. We systematically investigated the possible effect of MF on sensori-motor and autonomic recovery in clinically relevant rat model of complete paraplegia.

2. Materials and Methods

The spinal cord injury was performed under ketamine anesthesia (60 mg/kg) on adult male Wistar rats (200-250 g) in accordance with the rules and regulations of Institutional Ethical Committee concerning the use and care of laboratory animals. They were divided into sham (n=7), SCI (n=8) and SCI + MF (n=8) groups. The spinal cord was severed at T11 (13). The end of the cord was distracted and the cavity was then carefully explored with a glass probe

to cut any residual fibers and packed with gel foam. Postoperative intensive care included bladder expression daily, i.p. injection of antibiotics and maintenance of general hygiene.

Sensori-motor Assessment

1. Motor behavior was assessed during a 4-min. observation period in the open field by locomotor rating scale (BBB score) (14).
2. Sensori-motor functions were assessed by determining the latency of motor response of tail (TFL) to thermal (48°C) stimulus. Its threshold (TTF) of motor response of tail to electrical stimulation of nociceptive afferents, simple vocalization (SV) and vocalization after discharge (VAD) were also determined.

Magnetic field (MF) exposure

Exposure to MF (17.9 μ T and 50 Hz in the centre of axis, where the rats cage was placed) was carried out in magnetic field chamber consisting of electromagnetic coils mounted on a stand along with movable platform for the rat cage (15).

Study Design: Food intake (FI) and water intake (WI) daily, body weight (BW) & BBB score weekly and TTF & TFL at alternative week were assessed. MF exposed group of rats received exposure 2h/day for 8 weeks (10:00 – 12:00 h). The control groups of rats were similarly treated except for switching on the power supply of exposure chamber.

Statistical analysis

All data are represented as means \pm SD. Statistically significant differences were determined by using one-way ANOVA and nonparametric Kruskal-Wallis rank test for overall changes ($P<0.05$).

3. Results

Sensori-motor Assessment

BBB score: A gradual albeit significant improvement in locomotor functions is observed in MF exposed (1.00 ± 0.00 and 9.00 ± 0.00 post SCI wk 1 and 8 respectively) rats as compared to SCI group of rats (1.00 ± 0.00 and 3.00 ± 0.00 post SCI wk 1 and 8 respectively, $P=0.000$).

Body weight: After the spinal cord injury BW decreases in all the groups (221 ± 3.77 g in SCI + MF; 216 ± 11.8 g in SCI at 1st wk as compared to normal rats) during 1st, 2nd, 3rd and 4th week and after that they start gain the weight (234.28 ± 6.72 g in SCI + MF; 205.71 ± 10.96 g in SCI) but the statistically significant improvement of BW in MF exposed group.

Food Intake and water intake: A statistical significant ($P=0.000$) decreased in food and water intake post SCI wk 1 as compared to their pre-surgery intake. From 2nd wk, there is an increase in FI & WI till post SCI 8 wks 8th wk.. MF exposed rats ingested more food and water as compared to SCI group of rats throughout the period of observation.

Tail flick latency (TFL): In SCI rats, there was hyperalgesia at post SCI wk 1 (7.91 ± 0.58 sec and 6.7 ± 0.8 sec at post SCI wk 1 and 8 respectively) as compared to MF exposed group (at post SCI wk 1, 8.08 ± 0.56 to 8.67 ± 0.52 sec post SCI wk 8). When compared to SCI group, there is statistically significant improvement in MF exposed group at post SCI wk 5 and 7.

Threshold of tail flick (TTF): In SCI rats, there was hyperalgesia (at post SCI wk 1, 0.33 ± 0.02 to 0.27 ± 0.02 volt post SCI wk 7) as compared to MF exposed group (at post SCI wk 1, 0.35 ± 0.02 to 0.54 ± 0.06 volt post SCI wk 7). When compared to SCI group, there is statistically significant improvement in MF exposed group at post SCI wk 1, 3, 5 and 7.

Threshold of simple vocalization and vocalization after discharge: A significant analgesia persisted throughout the period of observation in both the groups of rats.

Rate of self-mutilation and bladder control: In MF exposed group, there is an improvement in bladder control (85%) and reduced the incidence of self-mutilation (95%) and increased survival rate as compared to SCI group of rats.

4. Conclusion

Our study suggests that a significant recovery in locomotion, sensori-motor, autonomic functions in spinalised rats exposed to 2 h/d x 8 wks to 17.9 μ T MF. This is reflected by an increase in survival rate and decrease in autotomy behavior of these rats.

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6. References

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