Physiological effects of microwave irradiation in mice

Ming-Fang Wu[1)], Hung-Wei Chiu[2)], Kenichi Saito[3)]

[1)] Animal medicine Center, School of Medicine, National Taiwan University, No. 1 Jen-Ai Road, 1st Section Taipei, 100 Taiwan.
[2)] Department of Electronic Engineering & Graduate Institute of Computer and Communication Engineering, National Taipei University of Technology, No. 1, Section 3, Chung-hsiao E. Road, Taipei, 10608 Taiwan
[3)] Laboratory of Environmental Health and Food Science, Nippon Veterinary and Life Science University, Musashino, Tokyo 180-8602, Japan

Abstract

ICR mice were used in this research. The experiment and control group both has 5 male and 5 female mice, which are 6 weeks of age. The physical appearance or outward phenotype of the irradiated mice and its offspring were not significantly influenced by microwave irradiation. After 6 month irradiation, the mice of the control and experiment group were all conducted euthanasia. After euthanasia, the blood was collected from the heart for biochemical analysis. The physical performance is also normal after irradiation. There is no deformity appearing in the mice of this experiment. The number of the offspring is not significant different after born. The sex-ratio (male/female) of the offspring is up to 86% in the irradiation experiment of 3GHz microwave. No significant difference is found in the blood cell number. Because there is also no significant difference occurring in the tested BUN, the renal function is also normal. Besides, GPT and GOT significantly increase in female rats but don't significantly change in male mice. Congo red used to examine the pathology of the brain tissue showed amyloidosis in mice under 3-GHz irradiation. Tau immunohistochemical stain, which is usually used for the diagnosis of the Alzheimer's disease, showed positive response in mice.

Presented at the 31st ISAS Space Energy Symposium, 24 February, 2012

Introduction

There are and more wireless applications emerging. In addition to the conventional wireless communications, wireless power transmission also emerges to replace the wired power supply. The wireless power transmission can be used to transmit solar power from space. A recent popular application is to wirelessly charge the mobile devices for convenience. Besides, an implantable device can also use this technology to remove the battery. With more high power microwave surrounding in our living environment, the biological effects of microwaves should be investigated more. Many studies have investigated the irradiation frequency at the 2.4GHz. In the study, we focus the frequency to a higher frequency 3GHz.

Material and methods

ICR mice were used in this research. The experiment and control group both have 5 male and 5 female mice, which are 6 weeks of age. The mice of each group were housed to a cage in a room. The laboratory was maintained on a 12-hour light-dark cycle(light on 6:00-18:00h) and at an ambient temperature of 20~22℃ and a relative humidity of 65%. Animals were given food and water ad libitum. The experiment mice are housed in a cage placed above the microwave radiator as shown in Fig.1. The microwave radiator consists of a signal generator, a power amplified, a horn antenna and a power supply module. The signal generator is a frequency synthesizer controlled by a micro-controller. The generated 3-GHz signal is sent to the power amplifier, which deliver a 3-W output power to the following antenna, which is a double ridged (TEM) broadband horn antenna with an antenna gain of 12dBi. The experimental group is irradiated at the average irradiation power density of 0.1mW/cm^2 for 6 months.

After 6-month irradiation, the mice of the control and experiment group were all conducted euthanasia. After euthanasia, the blood was collected from the heart for biochemical analysis. EDTA was used to prevent clotting of blood cell. In order to count the number of the red blood cell, white blood cell and lymphocyte cell, serum was centrifuged. In addition, serum was also used for liver function tests (GOT and GPT) and renal function test (BUN).

For the examination of histopathology and immunohistochemistry, the brain tissue obtained from mice was placed in a fixative which stabilizes the brain to prevent decay. The fixative is formalin (10% formaldehyde in water). The brain tissue was transferred to a cassette, a container designed to allow reagents to freely act on the tissue inside. This cassette was immersed in multiple baths of progressively more concentrated ethanol, to dehydrate the tissue, followed by toluene or xylene, and paraffin. During this 12 to 16 hour process, paraffin will replace the water in the tissue, turning soft, moist tissues into a sample miscible with paraffin, a type of wax. The processed tissue was then taken out of the cassette and set in a mold. Through

this process of embedding, additional paraffin was added to create a paraffin block which was attached to the outside of the cassette. The process of embedding then allows the sectioning of tissues into very thin (2 - 7 μm) sections using a microtome. The microtome slices the tissue ready for microscopic examination. The slices are thinner than the average cell, and are layered on a glass slide for staining.

Then, the brain tissue stain was performed for the examination of histopathology. Hematoxylin and eosin (H&E) was used in the histopathology. Hematoxylin is used to stain nuclei blue, while eosin stains cytoplasm and the extracellular connective tissue matrix pink. Congo red was used to selectively stain cells.

Besides, the immunohistochemical study of tau accumulation was also examined for detecting the microwave induced of Alzheimer-type neurofibrillary lesions.

Results and Discussions

The physical appearance or outward phenotype of the irradiated mice and its offspring were not significantly influenced by microwave. The physical performance is also normal after irradiation. There is no deformity appearing in the mice of this experiment. The number of the offspring is not significant different after born. The sex-ratio (male/female) of the offspring is up to 86% in the irradiation experiment of 3GHz microwave. No significant evidence is found in the blood cell number. Because there is also no significant difference occurring in the tested BUN, the renal function is also normal. Besides, GPT and GOT significantly increase in female rats but don't significantly change in male rats.

Cong red fluorescent stain of the brain tissue is used to for the diagnosis of the pathology. Fig.3(a) is the stain of a control mouse. Fig.3(b) shows that the deposits of amyloid were detected in the brain tissue of the irradiated mice.

Besides, tau immunohistochemical stain, which is usually used for the diagnosis of the Alzheimer's disease, was also used to exam in the brain tissue of the irradiated mice. This antibody raised against the bovine tau protein, crossreacts with the phosphorylated form of human tau protein enabling the conformational dependent epitope found only in the neurofibrillary components in Alzheimer's disease.

From the stain results of the brain, the microwave irradiation has effects on the brain as shown in Fig.4(b), where also shows the plague in the brain tissue. Otherwise, immunohistochemistry stain of tau is negative in the control group as shown in Fig.4(a).

References

[1] S.M. Michaelson, "Microwave biological effects: An overview," *Proceedings of the IEEE* , vol.68, no.1, pp. 40- 49, Jan. 19801

[2] Belyaev, I.Y.; Shcheglov, V.S.; Alipov, E.D.; Ushakov, V.D. , "Nonthermal effects of

extremely high-frequency microwaves on chromatin conformation in cells in vivo-dependence on physical, physiological, and genetic factors," *IEEE Transactions on Microwave Theory and Techniques*, , vol.48, no.11, pp. 2172- 2179, Nov 2000

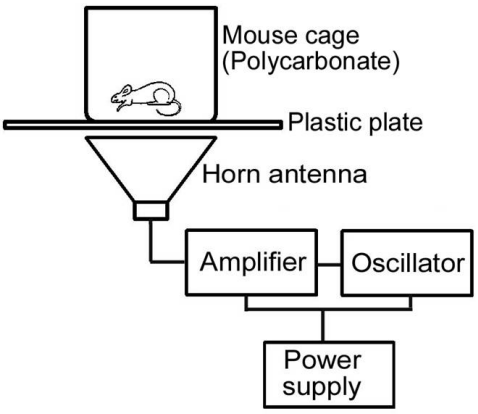

Fig.1 Microwave radiator

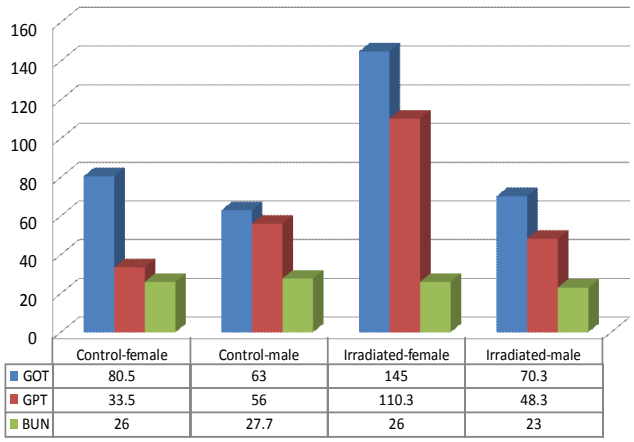

Fig.2 Biochemical results

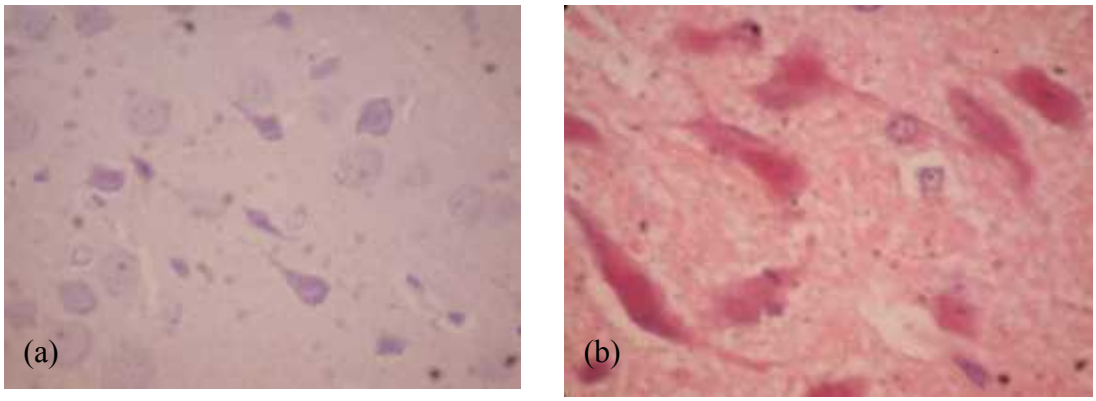

Fig.3 Congo red stained brain tissue of the (a) control group (b) experiment group.

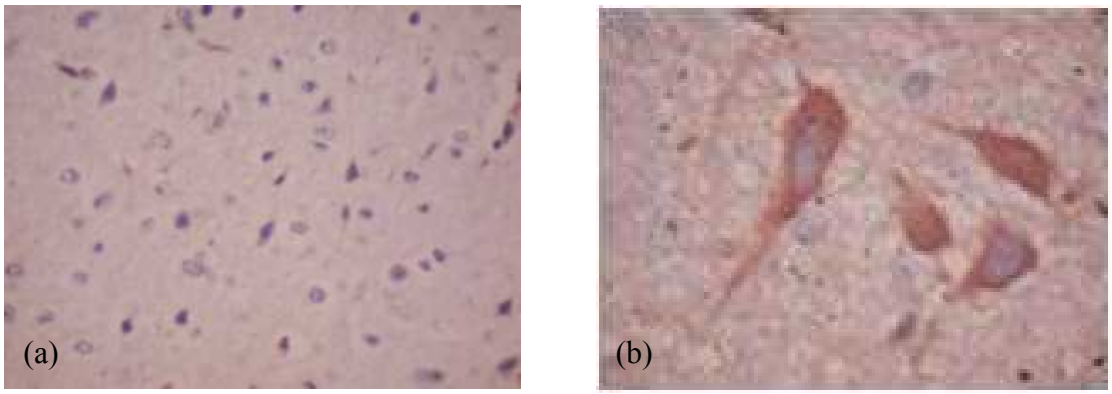

Fig.4 Tau immunohistochemical stain of the brain tissue in the (a) control group (b) experiment group.