INTRODUCTION

With the extensive application of microwave technology and the arriving information era, microwave biological effects and mechanism become the topics at the forefront of bioelectromagnetics. Blood-brain barrier (BBB) in the maintenance of environmental stability of the brain plays an important role in the process, its function is based on the structure of the brain capillary endothelial cells and their intercellular tight junction (TJ). Occludin is directly involved in the TJ formation, which as a kind of key TJ proteins, and plays an important role for the maintenance of BBB permeability, its expression changes may be directly results in the BBB dysfunction, thereby affecting the balance of the brain environment. The research aims to explore the rule of occludin expression changes in rat hippocampus after a long-term low doses of microwave exposure, in order to identify the mechanism of occludin in the microwave exposure-induced brain injury.

MATERIALS AND METHODS

160 male Wistar rats were exposed to simulating resource of microwave at 2.5, 5 and 10mW/cm², injected with Evans Blue (EB) Staining Solution, sacrificed at 6h, 7d, 14d, 1m and 2m after the exposure. To observe the changes of brain capillary morphous and the tight junction structure by light microscopy and transmission electron microscopy. The EB dye and laser confocal microscope were used to review the permeability of BBB. Western Blot, Real-Time PCR and image analysis methods were used to test the gene and protein expression of Occludin to explore the possible molecular mechanism of microwave exposure-induced BBB damage.

RESULTS

After 2.5, 5 and 10mW/cm² microwave exposure, (1) BBB structural changes in rat hippocampus: the capillaries in the brain dilated slightly, with the tissue looseness and edema. The wider capillary gaps were found. During the ultramicrostructure observation, it was found that the astrocytes and endotheliocytes edema, the capillary gaps were broadened and TJ structure was vague or widened. (2) The permeability to the EB in the BBB at hippocampus was increased: In sham-group, the red fluorescence of EB was limited in lumens of blood vessels, while it surrounded the blood vessels at 7d in exposure groups, the damage of BBB aggravated after microwave exposure, which was not recovered in 1m. And the lesions tended to be worse with the increased exposure dose. (3) Occludin protein in rat hippocampus was reduced: Compared with sham-exposure group, occludin protein expression began to decrease (P<0.05) at 7d after 5 and 10mW/cm² exposure, which was progressive declined in 1m (P<0.01) and recovered at 2m. (4) Occludin mRNA in rat hippocampus was changed: Compared with the sham-exposure group, no significant changes of occludin mRNA were found at 6h and 7d in exposure groups, while there was a significant
decrease at 14d ($P < 0.01$), and the occludin mRNA were all reduced to a minimum value at 1m after 2.5, 5 and 10mW/cm$^2$ microwave exposure ($P < 0.01$), then resumed at 2m.

**CONCLUSIONS**

After the exposure of 2.5, 5 and 10mW/cm$^2$ microwave on rats: (1) Construction of BBB in cerebral hippocampus could be damaged and the TJ structure become widened, the foot process of astrocytes edema; (2) The BBB structure may be breakdown which would increase the permeability to macromolecular indicator, and the disease extent was positively correlated with the exposure dose; (3) The occludin expression in hippocampus was decreased, and the variance of occludin has a positive correlation with the structure and function changes of BBB, which indicate that it may be involved in the change of BBB permeability induced by microwave exposure.

**REFERENCES**


