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The Effects of Aerobic Exercise on Spatial Learning and Memory and Expression of PDE-4 in Hippocampus of the Aging Rats

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Objective To discuss the effect of aerobic exercise intervention before aging rats and on aging rats, the spatial learning and memory abilities and the expression of PDE-4 in hippocampus.

Methods 64 male SD rats were divided into 4 groups at random (n=16): control group (group C), D-galactose aging model group (group A), Pre-aging aerobic exercise intervention group (group S1), Aerobic exercise intervention on aging group (group S2). After 6 weeks, each group was randomly divided into Morris water maze behavior training group (M group) and natural feeding group (N group), record as CM, AM, S1M, S2M, CN, AN, S1N, S2N. At the end of 7th week, all rats were killed and the cerebral cortex SOD, GSH-PX and MDA content were tested; The expression of PDE-4 gene in hippocampus was detected by Real-time PCR and Western blotting.

Results 1) The general state: When compared to the rats in C group, which in A group show obvious symptoms of aging, such as lethargy, loss of appetite, slow, yellow curly hair color, even off signs and so on; but S2 group were similar to C group; S1 group were a little worse than S2 group. 2) HE staining: When compared to the rats in C group, the hippocampus neurons in A group were disordered, the cells staining were deepened, the cytoplasm were edema, most of the interstitial cells were loose, and other morphological structure in aging state; S2 group were similar to C group; S1 group were a little worse than S2 group. 3) The free radical detection: Almost no difference in each corresponding M group and N group. The activities of the cerebral cortex SOD and GSH-PX in were consistent: C group and S2 group were significantly or very significantly higher than others ($P < 0.05/0.01$); The cerebral cortex MDA content: C group was the lowest, S2 group followed, and all significantly lower than those in A group and S1 group ($P < 0.05$). 4) The Morris water maze test: the Positioning navigation experiment results showed that the spatial memory was preliminarily formed on the day 2, CM group, S1M group and S2M group formed stable spatial learning and memory on day 3, but that of AM group formed on day 4; The space exploration test results showed that the maximum number of times of through the site was CM group, the percentage of the original site quadrant of CM group was the highest, and there was a very significant difference with the other groups ($P < 0.01$); S2 group followed, but AM group and S1M were relatively low. 5) The results of Real-time PCR and Western blotting: When compared to the rats in C group, which in A group and S1 group were very significantly higher ($P < 0.01$), but which in S2 group was very significantly lower ($P < 0.01$); When compared to the rats in A group, which in S2 group was very significantly lower ($P < 0.01$), but S1 group were significantly higher ($P < 0.01/0.05$); When compared to the rats in S1 group, which in S2 group was very significantly lower ($P < 0.01$).

Conclusions 1) Aerobic exercise can improve the antioxidant capacity of the brain, protect and repair the hippocampal neurons, change the morphological structure of hippocampal neurons, improve and maintain the brain's spatial learning and memory, and thus delay brain aging. 2) Aerobic exercise intervention can down-regulate the expression of PDE-4 gene, may directly activate the cAMP/PKA/CREB signal transduction pathway to promote the synthesis of some learning memory proteins, thereby improving the learning and memory ability of aging rats and delay brain aging. 3) The different periods of aerobic exercise on brain aging intervention were different. Aerobic

exercise intervention in the aging process performed relatively well. Tip: sustained aerobic exercise need to better play its role.