LUPINE PUBLISHERS

Orthopedics and Sports Medicine: Open Access Journal

DOI: 10.32474/OSMOAJ.2018.02.000137

ISSN: 2638-6003

Research Article

Effects of Circadian Rhythm Disorder on Learning and Memory in Mice

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Received: December 05, 2018 **Published:** December 13, 2018

Abstract

Objective: The change of learning and memory was explored in circadian rhythm disorder mice induced by irregular light/dark cycle.

Methods: Mice model of circadian rhythm disorder induced by irregular light/dark cycle. Twenty-four male ICR mice were raised under different light/dark cycles including LD 12h/12h (Group 1: Normal circadian rhythm group), light 3h next to darkness 5h and light 5h next to dark 3h alternate every other day (Group 2: Circadian rhythm disorder group). The twenty-four ICR mice were randomly assigned to these two groups and feed six months. Each group included twelve. Morris Water-maze task was used as the judging criteria for spatial learning and memory.

Result: The learning and memory was significantly decreased in circadian rhythm disorder mice induced by irregular light/dark cycle ($P<0.05$).

Conclusion: Circadian rhythm disorders impaired learning and memory.

Keywords: Circadian Rhythm; Light/Dark Cycle; Learning and Memory; Mice

Introduction

Circadian rhythm is a kind of biological a biological characteristic, animals' plants and microbes-many cellular are regulated with 24-h periodicity by endogenous pacemakers or exogenous zeitgeber signals [1-3]. Circadian rhythm is governed mainly by the suprachiasmatic nucleus (SCN) and molecular clock genes, but the molecular mechanisms of circadian rhythm in peripheral tissues are not yet fully elucidated [4-6]. Circadian rhythm disorder is a common symptom of dementia [7-9]. But is it unclear whether circadian rhythms are one of the causes of dementia? [10-12] Memory and learning ability decline is the core manifestation of dementia [13]. This study was to investigate whether circadian rhythm disorder is one of the causes of dementia by observing the learning and memory of circadian rhythm disorder animal models induced by light-dark cycle.

Materials and Methods

Animals and Experiment Design

Animals: ICR mice weight 8-10g, were purchased from Chengdu branch of the Chinese Academy of Sciences Co., Ltd., China.

Animal Feeding and Treatment: Twenty-four were randomly assigned to these two groups, each group included twelve mice. These animals were tested in water maze. The light dark cycle time of each group was LD 12h/12h (Group 1: Normal circadian rhythm group), light 3h next to darkness5h and light 5h next to dark 3h alternate every other day (Group 2: Circadian rhythm disorder group). The ambient temperature is controlled (22±2)°C.

Detection of ICR Mice Activity: Isolating ambient noise and lines, free water intake, free feeding, feeding for 6 months. These

ICR male mice and raised in a temperature-controlled environment (22±2)°C and with 50-60% humidity.

ICR Mice Activity Detection Equipment Includes: Environmental condition control box containing runner, infrared detector and data analysis system. The environmental condition control box controls the ambient temperature to (22±2) °C, isolates external noise and light, and automatically provides light-dark cycle according to the experimental design. Infrared detection device and data analysis system collect and analyze data separately. The activity of mice was continuously detected, and 1 time were recorded every 3 min.

The Morris Water Maze Test

The method of The Morris water maze test was reported previously [14-15]. The Morris water maze was conducted in a circular pool (120cm in diameter and 45cm in height) with a featureless inner surface. The water-maze tank was placed with four external visual cues and filled with water containing a nontoxic white color. The temperature of the water was maintained by 23-25°C. A white platform (10cm in diameter and 30cm in height) was placed in one of the quadrants with equal area and submerged 2cm below the water surface. During each trial session, the escape latency time spent to find the hidden platform was monitored by a video tracking system. During the four subsequent days of training the mice were given three trials per day with the submerged platform in the pool. When the mouse located on the plated platform, it was allowed to remain on it for an additional 10sec. If the mouse did not find the hidden platform within 120sec, the mouse was guided to the platform and permitted to remain on it for an additional 10sec. On the last day, the hidden platform was removed from the water-maze tank and probe test was performed. Mice were allowed to swim for 90sec and the staying time in the maze quadrant where the platform had previously been located was recorded.

Data Analysis

The data were reported as means ± SE. Bonferroni t-tests was used to analyze data. The overall level of statistical significance was $p<0.05$.

Results

The activity of the mice decreased in the light state and increased in the dark state when the activity cycle was consistent with the light-dark period. The water maze test showed that the time of finding the platform mice in group 2 was significantly longer than that in group 1 (Figure 1).

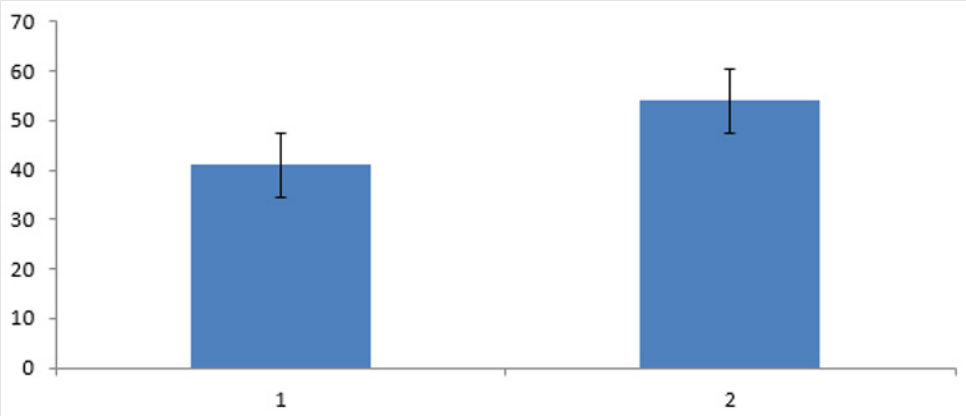

Figure 1: 1) Normal circadian rhythm group. 2) Circadian rhythm disorder group. The figure showed that ability of Mice in group 2 was lower than these in group 1.

Discussion

The experiment results showed that the learning and memory abilities of circadian rhythm disorder animal models induced by light-dark cycle were significantly decreased. The rotation of the earth formed living environment cycle about 24 hours, including light/dark cycle. As a result, the earth's organisms produce circadian rhythms. The circadian rhythm of organisms is the result of biological adaptation to the environment [16]. 24 hours light/dark cycle was the main cycle, and the formation of circadian rhythms in organisms may be mainly caused by light/dark cycle [17-20]. The circadian rhythm model induced by light dark circulation has become a common method to study circadian rhythm [21-22].

The circadian clock of mammals is located in the suprachiasmatic nucleus of hypothalamus. The circadian rhythm produced by molecular oscillation controls and affects mammalian physiology and behavior through many ways, such as activity, arousal and sleep, hormones and so on. Wakefulness and sleep are controlled by the brain. [23-24] Circadian rhythms can affect arousal and sleep prompting, which can affect brain function, including learning and memory. This study main showed that circadian rhythms can also affect learning and memory abilities.

The essence of the study is the discussion of phenomena and no mechanism for the formation of phenomena. Therefore, this is precisely the limitation of the study. However, this provided a basis for the discussion of mechanism. The study concluded that

circadian rhythm disorder can lead to impaired learning and memory in animals.

Acknowledgement

The authors thank the staff of the State Key Laboratory of Management and Control for Complex Systems institute of Automation, Key Laboratory of Chronobiology of Health Ministry in Basic and Forensic School of Sichuan University and the Department of Geriatrics of the third hospital of Mianyang and all study participants (as well as their legal proxies) for their great contributions.

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DOI: 10.32474/OSMOAJ.2018.02.000137