

Effect of 1/f Fluctuation Signal on the Slope of EEG α - α Interval Fluctuation

Tae Im Pak, Riong Heb Sim, Hyok Ju, Hye Kyong Han, Won Jon*

ABSTRACT

The objective of this study was to investigate the effect of 1/f fluctuation wave on EEG α - α interval and stability of cell membrane. We compared and analyzed the effect of 1/f fluctuation with different character of signal and slope on the fluctuation of EEG α - α interval in healthy men and grey rabbits, and studied the effect of 1/f fluctuation on the stability of cell membrane. Main outcome measures were EEG and stability of cell membrane. The gradient of EEG α - α interval fluctuation was increased to 142% by electromagnetic field with 1.5 of β value and to 135% by sound impulse with 1.5 of β value and character of 1/f. After 1/f fluctuation signal act, erythrocyte membrane osmotic resistance was increased by 34~38%. Sound wave and electromagnetic wave with property of 1/f fluctuation increase the gradient of EEG α - α interval fluctuation (β value) to the normal values. (b) Slope (β -value) of EEG α - α interval fluctuation is irritable (sharp) indicator reflecting condition of brain. (c) 1/f fluctuation signal increases the stability of cell membrane.

Key words: 1/f fluctuation, EEG α - α interval fluctuation, ECG R-R interval, Slope β , Power spectrum density.

INTRODUCTION

1/f fluctuation is rhythmical wave that power spectrum density is inversely proportional to frequency. That is $PSD = 1/f$ (PSD: Power Spectrum Density). Normal biological rhythm is 1/f fluctuation.^[1-3] Effect of 1/f electromagnetic wave on ECG R-R interval fluctuation was found out but effect on EEG α - α interval fluctuation was not found out. Effect of sound wave of 1/f fluctuation on EEG α - α interval was not clarified either. Therefore we carried out our research whether or not sound wave with 1/f fluctuation giving the sense of security on people could be applied to clinical practice instead of electromagnetic wave with 1/f fluctuation when the slope of EEG α - α interval fluctuation was decreased after intensive mental work or during the geomagnetic disturbance.

MATERIALS AND METHODS

Subject

36 healthy men (aged 40~60) were included in the study. 64 grey rabbits with 1.6-1.8kg of weights were used.

Procedure^[4-6]

Induction of EEG and recording up of EEG α - α fluctuation data

EEG was recorded by using 6 channel (EEG I A. 97A) of EEG, time constant 0.3 sec, filter 15Hz, 30sec, at international standard induction P3, P4.

Measurement of cell membrane permeability

In order to measure the cell membrane permeability, we measured osmotic resistance of erythrocyte membrane.

After 0.5ml of blood was gathered from vein of rabbit ear, it was mixed in blood: 5% citrate = 4:1. After 50ml of 0.9% NaCl solution was added, study group and control group were distinguished and stored at the same condition for 10min. And they were centrifuged at 1000r/min for 10min, supernatant fluid was removed, 50ml of 0.9% NaCl solution was added again and 5ml of 20% urea solution was added for destruction of erythrocyte membrane. Next after centrifugation at 1000r/min for 10min again, absorbance of supernatant liquid was measured by colorimeter (MPR-A), and automatically recorded result was compared and analyzed.

Action signal and period

Sound wave of 1/f fluctuation and electromagnetic wave of 1/f fluctuation were acted for 10 min.

F-EM; stochastic disturbance sine wave with 1/f property from 0.1 to 40 Hz, electromagnetic wave (0.005 Oe), $\beta = 1.5$, $\beta = 1.0$

F-S; the music with 1/f fluctuation slope and 1.5 of β -value

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Recording and analysis of EEG

At international standard induction system P3 and P4, it was recorded for 300sec, the number of α - α variation was 600. At this time, size of samples N, was 512.

RESULTS

Comparison of EEG indices and other indices after drinking water

Twenty minutes after drinking water, pulse, α - frequency of EEG and power spectrum slope (β) of α - α interval fluctuation were measured and compared. Table 1 shows, β -value of EEG α - α interval fluctuation was increased to 154%. Therefore β -value of EEG α - α interval fluctuation was sharp index reflecting condition of brain (Table 1).

Effect of 1/f fluctuation different signals on slope of EEG α - α interval fluctuation

After 10 min of action of 1/f fluctuation electromagnetic wave signals with the β -value of 1.5 and 1.0 (F-EM) respectively, variation at slope of power spectrum of EEG α - α interval fluctuation was measured (Table 2).

Effect of 1/f sound wave on slope of Power Spectrum of EEG α - α interval fluctuation

β -value of EEG α - α interval fluctuation increased 42% by weak intensity electromagnetic field with 1.5 of β -value and increased 35% by sound wave with 1/f property and 1.5 of β -value (Table 3).

As can be seen from above results, sound wave with 1/f property increases the slope of EEG α - α fluctuation to the normal values similar to electromagnetic wave. Sound wave with 1/f property acts positively on the slope of bioelectric potential rhythm of brain. Therefore we concluded

Table 1: Comparison of EEG indices and other indices after drinking water.

Index	n	Before	After	Variation (%)
Pulse(/min)	24	67 \pm 1.7	75 \pm 2.1	117
α - frequency.	24	9.41 \pm 0.05	9.07 \pm 0.08	96.3
α - α variation	24	0.201 \pm 0.032	*0.310 \pm 0.107	154
slope β -value				

*P<0.05(compared with before drink drinking water)

Table 2: Effect of 1/f different signals on β -value of EEG α - α interval fluctuation.

Signal F-EM	n	β -value of EEG α - α fluctuation		Variation (%)
		Before	After	
β =1.0	12	0.210 \pm 0.057	0.225 \pm 0.052	107
β =1.5	12	0.205 \pm 0.067	0.291 \pm 0.097	142

Table 3: Effect of 1/f sound wave on slope of Power Spectrum of α - α fluctuation.

Signal	N	β -value of EEG α - α fluctuation		Variation (%)
		Before	After	
F-EM β =1.5	12	0.205 \pm 0.067	*0.291 \pm 0.094	142
F-s β =1.5	22	0.201 \pm 0.059	*0.269 \pm 0.079	135

*P<0.05(compared with before action)

Table 4: Effect of 1/f signal on absorbance at different conditions.

Signals	Groups	n	Absorbance (M \pm SD)	Variation %
<i>In vivo</i> F-EM	Control	32	0.53 \pm 0.13	100
	Study	32	*0.35 \pm 0.08	66
<i>In vitro</i> F-EM	control	30	0.42 \pm 0.22	100
	study	30	*0.26 \pm 0.06	62

*P<0.005 (compared with control)

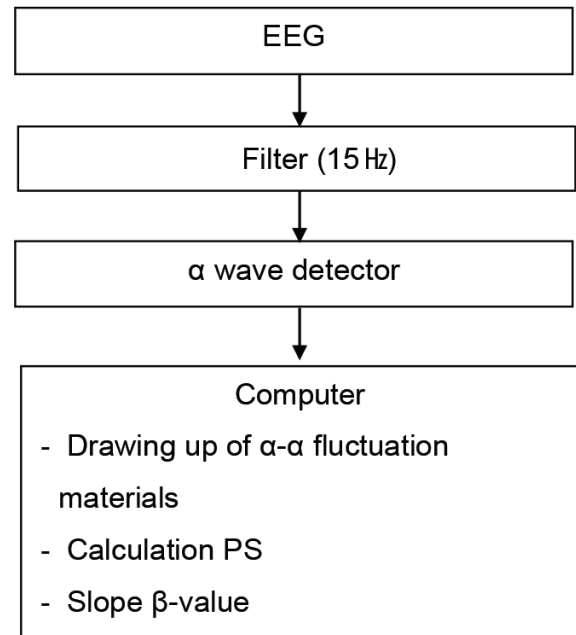


Figure 1: Calculation of EEG α - α β -value.

that sound wave with 1/f fluctuation giving the sense of security on people could be applied to clinical practice instead of electromagnetic wave with 1/f fluctuation.

Effect of 1/f fluctuation signal on stability of cell membrane

In order to observe the effect of 1/f fluctuation signal at level of cell, we measured erythrocyte membrane osmotic resistance.

Table 4 shows that absorbance was decreased 38% in study group compared to control group *in vitro* condition after acting the signal (0.1~400Hz) for 10min. It means that the stability of cell membrane is increased 38% after acting 1/f signal.

And also the absorbance was decreased 34% after living organism was irradiated directly in 1/f magnetic field. It means that cell membrane osmotic resistance was increased 34% after direct irradiation of 1/f signal, i.e. the stability of cell membrane was increased 34% after irradiation of 1/f signal *in vivo* experiment.

The action of 1/f signal in the cell level was to increase the stability of cell membrane, i.e. 1/f signal increased cell membrane osmotic resistance by 34-38%.

DISCUSSION

Slope (β -value) of EEG α - α interval fluctuation is irritable (sharp) index reflecting condition of brain. Sound wave of 1/f fluctuation also

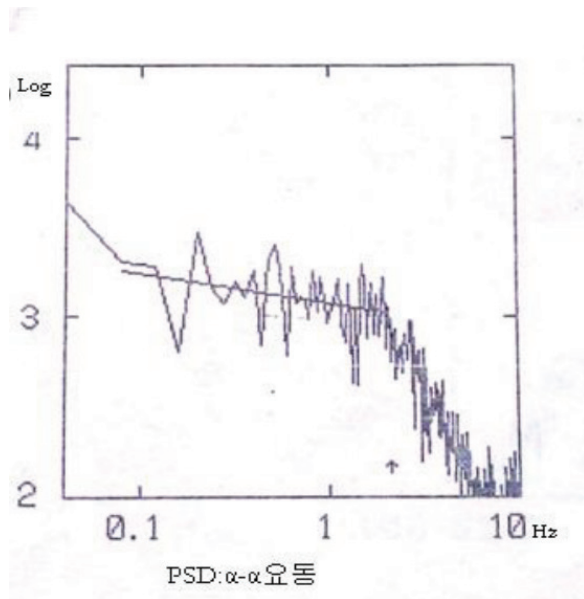


Figure 2: Slope (β) of EEG α - α fluctuation before 1/f signal act.

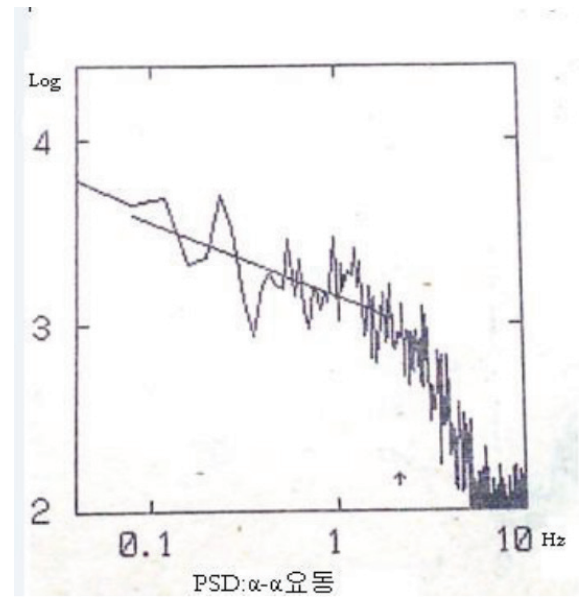


Figure 3: Slope (β) of EEG α - α fluctuation after 1/f signal act.

increases EEG α - α interval fluctuation slope (β -value) to normal values. The action of 1/f signal is the increase of the stability of cell membrane at the level of cell.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

PSD: Power Spectrum Density; **EEG:** Electroencephalogram; **ECG:** Electrocardiogram.

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