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Research Insomnia Disorders Related To The Neurological Problems

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Abstract

This study examines the: Sleep plays an important role in adjusting the balance of a stressful day since it helps to eliminate toxins and regenerating body energy. However, stressful life leads to sleeping disorders in many people. Lacking sleep causes dangerous health conditions such as cognitive decline, depression, and the most important one is a myocardial infarction. This study aimed at analyzing the sleep of healthy and insomnia subjects based on the characteristics and properties of brain signals. The power spectrum of the Alpha wave and the Delta wave was calculated and demonstrated on the graph for analyzing purposes. Based on the correlation between Alpha and Delta dual wave power spectrum, the condition of subjects was determined. Particularly, for insomnia subjects, the power spectral of Alpha and Delta correlated positively and vice versa. This research had successfully built a user interface for sleep detection using Brain mapping to visualize the power spectrum.

1 Introduction

Sleep is an extremely important part of the biological activity of the human body. For an average person, sleep usually accounts for 36% of life time. During sleep, some areas of the brain in the sleep state are more active than when awake. And our bodies secrete important hormones for recovery, replacement, and rebuilding functions throughout the day's work. In addition, the brain performs systematic rearrangement of information, establishing long-term memory. In fact, most people are not interested in the effectiveness of sleep and the consequences of lack of sleep or more serious than insomnia [1]. Insomnia is an expression of difficulty at starting sleep, difficulty in maintaining sleep or waking up in the early morning without being able to return to sleep, occurring at least three times a week. Insomnia seriously affects health: causes cognitive impairment, the risk of heart attack, can lead to death. Before this fact poses a need for a method of studying sleep disorders. These biological signals include: Electroencephalography (EEG), Electrooculography (EOG), Electromyogram (EMG) electroscope, ... The method that specialists use to assess the quality of sleep often is the identification of biological signal parameters through a sleep record.

There are many objective parameters to evaluate insomnia in clinical practice, based on Polysomnographic (PSG) recordings: Total Sleep Time, Sleep Onset Latency, Wake Latency, Wake, NREM1, NREM2, NREM3, REM, Sleep Quality, Duration of Awakenings and Sleep Efficiency Index, etc [2]. Insomnia diagnosis and treatment is difficult with these traditional parameters which do not exhibit a clear pattern [3]. In order to get an accurate evaluation result by this method, it takes a lot of time, the reader must be trained and experienced. In fact, it is necessary to have a tool to support doctors and users in diagnosis and treatment.

Therefore, this study concentrates on the research of insomnia related to neurology, not to mention stress or the environment affecting sleep. This study brings a more positive meaning to the diagnosis results and evaluates the brain's response to treatments with different causes.

2 Materials and Methods

2.1 Materials

In this study we utilised an existing sleep data of 37 adults was recommended by experts to measure sleep monitoring. The subjects had an average age of 46.7 years, they had problems maintaining a good sleep. A sleep diary was maintained for the duration of 8 hours. Their insomnia disorder was not linked to any other mental disorder or sleep disorder. At least three times per week or more the insomnia patients had complaints of falling asleep or maintaining sleep or nonrestorative sleep for the past three months. In the past three months, their sleep quality decreased at least three times per week. However, to verify the authenticity of the method, the study was conducted on students' regular naps. subjects tested from 20-25 years old, napping lasts about 60 minutes, the number is four.

2.2 Methods

The PSG data was recorded with sampling frequency of 200 Hz. EEG and EOG electrodes were used in accordance with the US AASM standard for sleep sleep monitoring: F4, O2, C4, A1, A2 [2], the filter band are filtered to 0.5 - 64 Hz for EEG and ROC, LOC for EOG. In addition, they were filtered from 47.5 to 52.5 Hz band to eliminate 50 Hz grid noise [3]. The movement artifacts were removed from the original signal by using an amplitude threshold value of 500 µV. All the signal processing was undertaken using Matlab software (MathWorks 2014b).

In this study, we utilised the Fourier Transform FFT formula to determine the spectral power of the EEG signal. Then, we based on the analyzed signals estimation to extract the EEG relative band powers.

The spectral power

The $F(w)$ was computed after Welch's method [5]

$$S(w) = \frac{F(w) \times F^{*}(w)}{m}$$

Where $S(w)$ was the ralative spectral power, $F(w)$ $F^{*}(w)$ were the Fourier Transform of EEG signals, m was the data length.

Alpha band showed a attenuation during sleep onset period and wake stage was scored when there was more than 50% of epoch has Alpha rhythm [6]. Delta was the characteristic wave for deep sleep stage N3. Delta band showed an increase during sleep onset period which was shown in [7] using sequential spectral analysis. Therefore the intersection of these two waves could be considered as maker points for sleep onset process. Delta power behaved reciprocally of alpha (e.g. when delta increased, alpha decreased and vice versa) [3]

In this study, we used another method to represent the analyzed signals, which was brain mapping. Brain mapping would performance the EEG spectrum power on an image that simulates the human brain. This method made it easy for viewers to see the results though images.

3 Results and Discussion

3.1 The spectral power

After data filter noise processing, we used FFT to analyze power spectrum of Alpha and Delta waves. In this study, we had three EEG channels to analyze include: C4M1, O2M1, F4M1. However, we utilised channels which clearly show the difference of the signal characteristics of two waves.

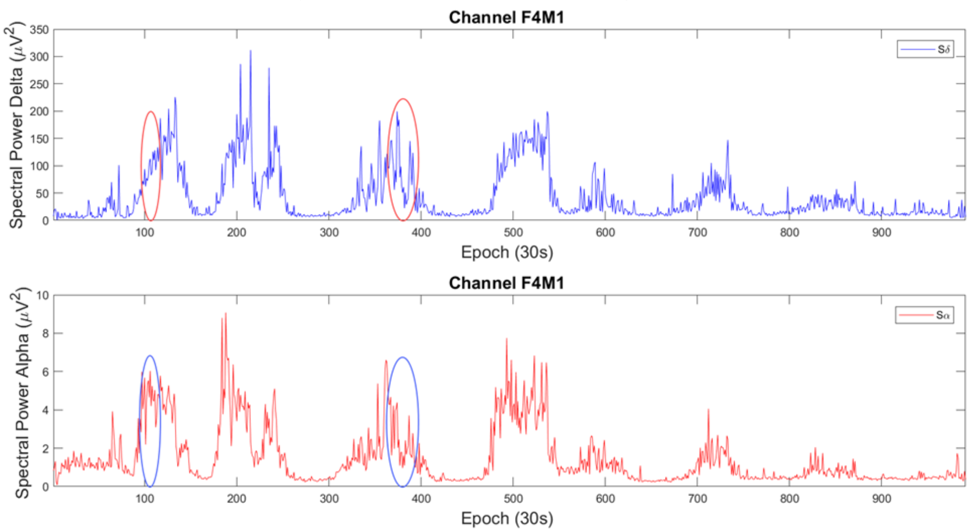

Figure 1: Power spectrum Alpha and Delta waves of subject ID_253. When both the spectrum Alpha and Delta increased or decreased, it was marked with circles

The same increase or decrease was called the positive correlation.

3.2 Relative spectral power

Relative spectral power would show the correlation of the 2-wave power spectrum on the same graph limited to -1 to 1. It can be also seen from Fig. 2

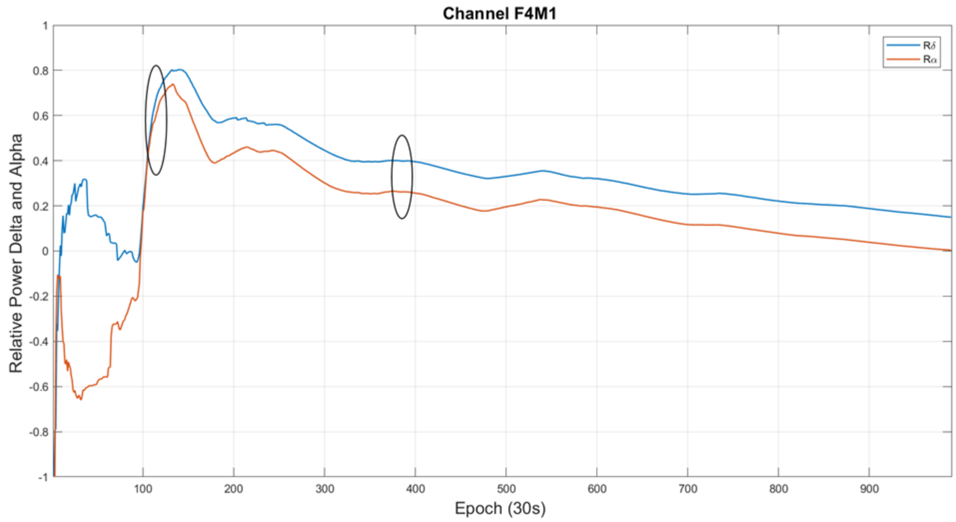

Figure 2: Relative spectral power of Alpha and Dellta waves of subject ID_253. The markers on the image were corresponding to Figure 1

According to the theory of brain waves, Alpha and Delta waves were not simultaneously increased or decreased at the same time. Therefore, the subject had an initial diagnosis of insomnia. The disorder has occurred over time from the beginning of sleep to sleep N3.

Table 1. Some parameters are extracted from the PSG report of the subject ID_253

Stage	W	N1	N2	N3	REM
Time (mins)	258.5	57	124.5	18	38
Alpha	3824	181	1402	39	47
Delta	4148	558	2404	410	102
Sleep performance	52.11%	11.49%	25.11%	3.63%	7.66%

Sleep performance index had shown part of the sleep quality of the subject. Stage Wake accounted for more than 50% and NREM sleep stages decreased. This reflected a sleep imbalance.

3.3 User interface

In order to create an easier review for viewers, we created a user interface. In the interface, there were items like: ID_number, Channels, Epoch, Sleep Detection,… Sleep Detection was the item, which used to assess sleep status through the PSG data. When the power spectrum of two waves Apha and Delta is positively correlated (e.g. they both increase or decrease), this interface will show Insomnia. Conversely, if the spectrum of these two waves was inversely correlated, the interface of Normall would appear. In this user interface, we also showed the graphs analyzed as shown in Figures 1 and 2

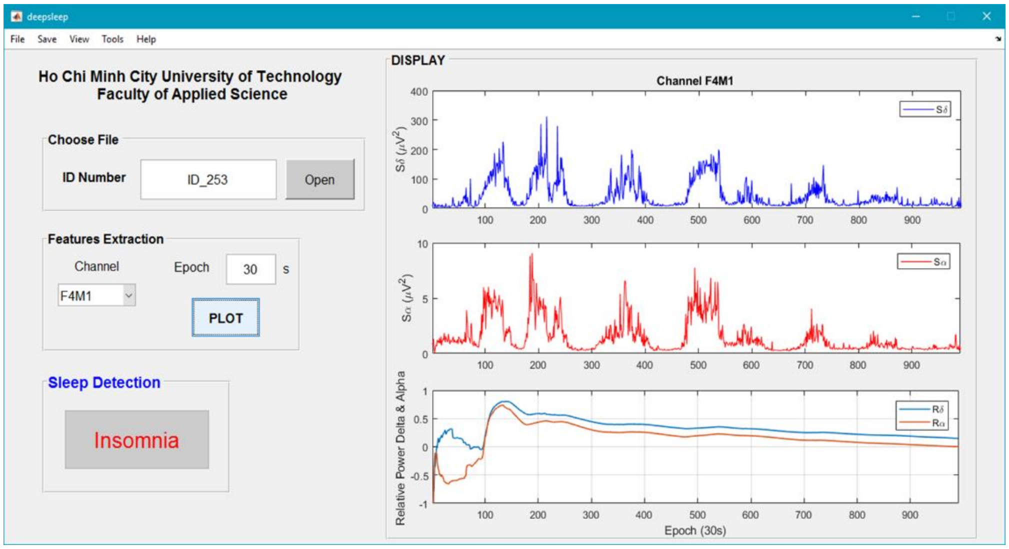

Figure 3: User interface is used for PSG of ID_253

3.4 Brain Mapping

It is known as another method to show the power spectrum of two Alpha and Delta waves. As shown in Fig. 4, there are two consecutive epochs, each of which is 30 seconds.

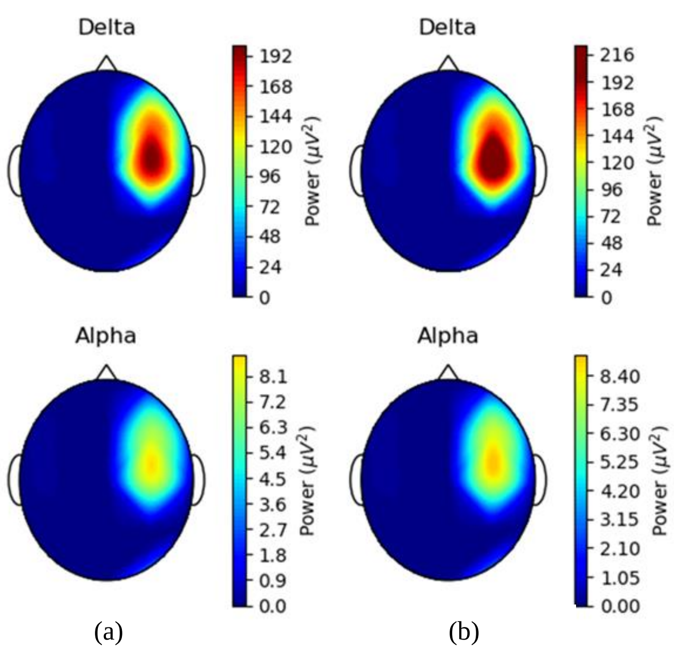

Figure 4: Brain Mapping performanced the power spectrum of three EEG channels of ID_253

According to observing the Hypnogram graph at this stage, the subject was sleeping NREM2 and NREM3 so the Delta spectrum reached the highest value and focused on C4M1. On the other hand, Alpha still appeared with a high power spectrum and a high concentration density on both the C4M1 region and the F4M1 region. And when the subject switches from (a) to (b), the Alpha and Delta wave power spectra were positively correlated. Therefore, the Alpha wave concentration at this stage represented an abnormal signal.

4 Conclusions

With the analysis and experimentation, this study does not assess the cause of the disorder or environment affecting sleep, but only concerns the disturbance of Alpha and Delta signal waves.

At different stages of sleep, the signal of the waves was very obvious. The power spectrum of Alpha and Delta waves had its own characteristics for sleep phases. For the average person, the power spectrum of Alpha and Delta waves would be inversely correlated (ie not both increased or decreased). However, if the power spectrum of these two waves was both increased or decreased - positively, this would be the insonia subject. The disorder was expressed in all sleep EEG signal channels typical for F4M1, C4M1, O2M1.

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