Electroencephalogram (EEG) Changes in Premenstrual Dysphoric Disorder (PMDD)

Binu Shrestha¹, Bishnu Hari Paudel², Nirmala Limbu³, Kopila Agrawal⁴, Dhana Ratna Shakya⁵, Mohan Regmi⁶

¹Assistant Professor, Neuroscience, Trinity School of Medicine, St. Vincent and the Grenadines.
²Professor, Department of Basic and Clinical Physiology, BPKIHS, Dharan, Nepal.
³Additional Professor, Department of Basic and Clinical Physiology, BPKIHS, Dharan, Nepal.
⁴Associate Professor, Department of Physiology, Birat Medical College, Biratnagar, Nepal.
⁵Additional Professor, Department of Psychiatry, BPKIHS, Dharan, Nepal.
⁶Associate Professor, Department of Obstetrics & Gynecology, BPKIHS, Dharan, Nepal.

Corresponding Author: Binu Shrestha

ABSTRACT

The prevalence of premenstrual dysphoric disorder (PMDD) is high among the reproductive age group of the female population. The aim of the study was to assess electroencephalogram (EEG) changes in PMDD and compare with healthy controls. The study was conducted on thirty female students of BP Koirala Institute of Health Sciences (BPKIHS), Dharan, Nepal with symptomatic PMDD and thirty female age-matched controls in Clinical Neurophysiology Lab of Department of Basic and Clinical Physiology, BPKIHS, Dharan, Nepal. Subjects were screened with questionnaire and research criteria of Diagnostic and Statistical Manual of Mental Disorders 4th edition (DSM-IV). EEG recordings of all the participants were done before menstruation start or during the peak of symptoms. EEG was dissected out into its constituent frequency bands by Fast Fourier Transformation and the data of EEG and other variables were compared in between groups. The findings showed increased frontal alpha 2 (p=0.039) in eyes-closed and frontal beta (p=0.014) in eyes-open condition among PMDD group as compared to the control group. Thus, the result is suggestive of the presence of feature anxiety, emotional stress, and poor sleep quality during the symptomatic phase of PMDD.

Keywords: Premenstrual dysphoric disorder (PMDD), Premenstrual syndrome (PMS), Electroencephalogram (EEG),

INTRODUCTION

Premenstrual dysphoric disorder (PMDD) is a severe form of premenstrual syndrome (PMS) that occurs in 3-8% of women, [¹] and an additional 19% identified as ‘near-threshold’ cases that failed to meet the strict PMDD criteria. [²] PMDD is classified as a ‘depressive disorder not otherwise specified’ in the American Psychiatric Association’s Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV) (American Psychiatric Association, 1994). [³] Although the etiology of PMS and PMDD remains uncertain at present, researchers now concur that these disorders represent biological phenomena rather than purely psychological events. Medical definitions of PMS are limited to a consistent pattern of emotional and physical symptoms occurring only during the luteal phase of the menstrual cycle that are of sufficient severity to interfere with some aspects of life. [¹]
Electroencephalogram (EEG) is the recording of electrical activity along the scalp produced by the firing of neurons within the brain. Studies showed that cyclical variation also occurred in the frequency of cortical electrical activity, and also reported an increase in slow-wave activity in the electroencephalogram (EEG) at the onset of menstruation. Study has shown that psychological and physiological changes occur during PMDD has an impact on day-to-day life which adversely affects the emotional well-being, occupational performance, and social relationship. So, the aim of this study is to investigate electroencephalographic changes in the PMDD and compare with controls.

MATERIALS AND METHODS
The Cross-sectional comparative study was conducted among the female students of BPKIHS. The groups PMDD and Controls were selected based on the inclusion and exclusion criteria. Female students of reproductive age between 18 to 30 years with regular menstrual cycle (28±7 days) and fulfilling research criteria DSM-IV were included. Female students with a history of seizure disorder or any psychiatric illness and major medical illness or taking drugs that show changes in EEG and also females on oral contraceptive pills were excluded. All the participants were explained about the study and recording procedures and informed written consents were taken. Documentation of detailed medical history and physical examinations were done. The study group (PMDD) was selected based on DSM-IV criteria. Both the groups had their anthropometric and cardiorespiratory variables measured.

Electroencephalogram (EEG) Recording
After screening with a questionnaire, anthropometric variables were measured. The participants were advised to rest for 10 minutes in a supine position on the dental chair after adjusting the head and back on the chair according to their comfort. The EEG recordings were undertaken in a quiet, relaxed environment, with the subject lying comfortably in supine position. Premenstrual EEG recordings were done for 6 minutes during eyes-closed, eyes-open conditions for 3 minutes each.

Data acquisition
EEG records were visually inspected on the computer to check for eye blink, detectable eye movement, and body movement artifacts. After visual inspection, three artifact-free-5-second epochs selected from just before the end of 1st, 2nd, and 3rd minute of EEG recording during eyes-closed and eyes-open phase. Thereafter, Fast Fourier Transformation (FFT) method was applied to these data for decomposition of EEG waveforms into sine wave components in terms of respective frequencies.

These components were used to estimate spectral power for frequency in the ranges of delta (0.5-4.0 Hz), theta (4.0-7.0 Hz), alpha1 (7.0-10.0 Hz), alpha2 (10.0-13.0 Hz), and beta (13.0-32.0 Hz) bands. The spectral power for each band thus obtained for different regions of the brain (as provided by the selected montage) was exported to Microsoft Excel worksheet files for further analysis. The powers from three epochs were averaged for each subject.

Statistical analysis
The data obtained for anthropometric variables, cardio-respiratory variables, and EEG power spectra exported to SPSS (version 18) and tested for normal distribution. The data of anthropometric variables, cardiorespiratory variables, were normally distributed and expressed in terms of mean ± standard deviation (SD).

The data of EEG power spectra were non-normally distributed, hence subjected to log transformation and statistical analysis was done. The EEG power spectra were expressed as mean ± SD. Independent t-test was used for comparison of anthropometric variables, cardio-respiratory variables, and EEG power spectra between the study group and healthy controls. A p-value of ≤ 0.05 was considered statistically significant.
RESULTS

The anthropometric variables (age, weight, height, and BMI) and cardiorespiratory variables (systolic and diastolic blood pressure, pulse rate, respiratory rate, and arterial oxygen saturation), when compared between PMDD group and control, did not show any statistical significance.

EEG power spectra during eye-close condition (Table 1) showed there was significantly more alpha2 activity in PMDD group than healthy controls at frontal (p=0.039) and temporal (p=0.010) sites.

EEG power spectra during eye-open condition (Table 2) showed there was significantly more beta activity at Frontal (p=0.014) in EEG of PMDD than control before menstruation.

<table>
<thead>
<tr>
<th>Electrode sites</th>
<th>Group</th>
<th>Delta</th>
<th>Mean ± SD</th>
<th>p</th>
<th>Theta</th>
<th>Mean ± SD</th>
<th>p</th>
<th>Alpha 1</th>
<th>Mean ± SD</th>
<th>p</th>
<th>Alpha 2</th>
<th>Mean ± SD</th>
<th>p</th>
<th>Beta</th>
<th>Mean ± SD</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMDD</td>
<td>40.89 ± 34.23</td>
<td>0.061</td>
<td>6.99 ± 6.37</td>
<td>0.773</td>
<td>20.72 ± 36.58</td>
<td>0.262</td>
<td>8.72 ± 6.42</td>
<td>0.038*</td>
<td>10.22 ± 6.14</td>
<td>0.417</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>28.74 ± 32.48</td>
<td></td>
<td>5.84 ± 3.95</td>
<td>0.601</td>
<td>22.92 ± 30.74</td>
<td>0.50</td>
<td>5.00 ± 2.83</td>
<td></td>
<td>8.14 ± 3.40</td>
<td></td>
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</tr>
</tbody>
</table>

| PMDD            | 30.37 ± 24.11 | 0.0247 | 10.19 ± 8.43 | 0.720 | 30.74 ± 93.34 | 0.575 | 47.83 ± 41.67 | 0.010* | 26.65 ± 18.50 | 0.242 |
| Control         | 22.02 ± 14.10 |       | 10.43 ± 9.23 | 0.613 | 93.11 ± 103.72 | 0.176 | 19.67 ± 14.83 |       | 20.10 ± 12.47 |       |

| PMDD            | 79.01 ± 34.03 | 0.0973 | 38.70 ± 33.79 | 0.815 | 93.90 ± 143.64 | 0.268 | 47.00 ± 38.45 | 0.390 | 39.29 ± 30.25 | 0.813 |
| Control         | 80.38 ± 40.96 |       | 36.25 ± 19.89 | 0.627 | 115.56 ± 137.07 | 0.339 | 33.69 ± 22.66 |       | 37.14 ± 25.78 |       |

| PMDD            | 64.28 ± 52.14 | 0.516 | 23.64 ± 25.62 | 0.601 | 88.43 ± 131.67 | 0.405 | 84.78 ± 75.83 | 0.487 | 37.80 ± 27.99 | 0.864 |
| Control         | 55.49 ± 38.59 |       | 25.88 ± 20.48 | 0.562 | 156.83 ± 289.62 | 0.587 | 58.27 ± 49.48 |       | 31.95 ± 19.50 |       |

| PMDD            | 52.54 ± 53.96 | 0.438 | 20.50 ± 24.39 | 0.551 | 110.46 ± 218.43 | 0.063 | 69.09 ± 73.14 | 0.544 | 35.19 ± 24.09 | 0.469 |
| Control         | 46.37 ± 30.84 |       | 17.94 ± 14.15 | 0.551 | 180.23 ± 225.50 | 0.503 | 53.03 ± 46.98 |       | 26.07 ± 13.33 |       |

**DISCUSSION**

The aim of the study was to investigate EEG changes among PMDD and controls. The results showed more EEG spectral power of alpha2 activity at the frontotemporal site, during eye close state and more beta activity at the frontal site during eyes-open state, in the premenstrual recording of PMDD group as compared to healthy controls. These findings are consistent with Pollock and Schneider, 1990 who reported increased in alpha and beta1 power during waking EEG in a patient with depression [7] and increased beta activity during waking is common in patient with psychiatric disorders. [8] So it can infer that study group must have symptoms of depression which are also included in
research criteria for PMDD. This is also supported by the study done by C. Buchpiguel et al. to determine changes in regional cerebral blood flow (rCBF) associated with PMS, which concluded that SPECT (Single photon emission computed tomography) imaging demonstrates modest decreases in rCBF in the temporal lobes that correlate with the level of depression in subject with PMS.

The present results are also consistent with the statement given by Niedermeyer E and da Silva FL. EEG beta1 power during waking state indicates cortical arousal. Another study also found a trend for increased power density in the 12-13 Hz narrow band during Non-REM sleep in the same group of women with severe PMS compared with controls in both the follicular and luteal phases of the menstrual cycle. Though there is increased beta1 activity, as shown by the present study, this study was done during sleep, thus discrepancy with our study seems natural.

The finding is in the line of a study done by I-Mein Lin et al. which showed higher frontal alpha asymmetry among the participant with PMDD than without PMDD in depressive induction and relaxation condition during the luteal phase. A study done by Scherzer et al. found a well-developed alpha rhythm in the emotionally very tense state.

The study done by Leary and Batho had compared between the EEG recorded in the premenstrual phase and those recorded at mid-cycle also had the result of a significant increase in mean alpha frequency and increase in mean alpha amplitude in premenstrual records. These findings may correlate with subjective mood changes commonly experienced by females in the premenstrual phase.

In contradictory to present result, Toner et al in 1995 found increased in delta activity during PMS along with a suggestive, but not necessarily significant decreased in beta activity, in their study sample size was 6 women of age ranged from 30 to 43. They were not grouped based on research criteria but were self-reported. They had 21- channel QEEG (quantitative EEG) recording and P300 evoked potentials measured during mid-cycle and premenstrual phase. Thus, the differences between this study and the study by Toner et al seem obvious.

CONCLUSION
The result of the study showed increased alpha 2 and beta activity in premenstrual EEG at the front temporal region among the participants with symptoms of PMDD which is suggestive of the presence of depression, anxiety, poor sleep quality, emotional stress in premenstrual dysphoric disorder patients.

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