Section: Physiology

Original Research Article

P300 CHANGES IN YOUNG ADULTS WITH DEPRESSION

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Abstract

Background: In India, the prevalence of depression in young adults is 1.6% (Males–1.2%, Females-2%). Accurate diagnosis of depression remains a significant challenge in clinical practice. Identifying objective biomarkers for depression is crucial for improving its diagnosis, prognosis, and treatment outcomes. One of these biomarkers is P300 event-related potential (ERP), a measure of cognitive processing that reflects the brain's response to stimuli. **Aims and Objectives:** This study provides an overview of P300 changes in depression exploring its potential as a valuable tool for diagnosis of depression based on specific cognitive deficits. **Materials and Methods:** 42 newly diagnosed patients of depression of the age group (18-26) years and 89 non-depressed volunteers matched for age, BMI and sex proportions were included in the study. P300 is recorded by the MEP Neurosoft 4 machine and analysed by Neurosoft Neuro-MEP.NET software on an auditory oddball paradigm. P300 latency and P300 amplitude are compared between the group of patients with depression and the group of healthy control subjects by unpaired t-test. A p-value less than 0.05 ($P<0.05$) is taken as statistically significant. **Results:** There is no statistically significant difference found in age ($p=0.8772$), weight ($p=0.8598$), height ($p=0.1897$), BMI ($p=0.2226$) and gender ($p=0.9407$) between case and control groups. Among the auditory P300 parameters; P300 latency ($p<0.0001$) is found significantly increased and P300 amplitude ($p=0.0007$) is found significantly reduced in patients with depression when compared with healthy control subjects. **Conclusion:** The observed reductions in P300 amplitude and prolonged latency reflect cognitive impairments associated with attention and information processing. Incorporating P300 as a biomarker in clinical practice has the potential to improve diagnostic accuracy, predict treatment response, and guide personalized interventions.

INTRODUCTION

Depression is a common and serious mental health disorder that affects approximately 3.8% of the world's population (approx. 280 million people) of all ages worldwide.[1] It is characterized by persistent feelings of sadness, hopelessness, and a loss of interest in activities that were once enjoyable; for at least two weeks. Other symptoms include indecisiveness; restlessness; feelings of worthlessness; hopelessness or guilt; low energy; change in appetite; significant loss or gain in body weight (> 5% in a month); reduced concentration; and thoughts of self-harm or even suicide.[2,3]

Depression is quite common among young adults of the age group 18-25 years because for most people this time is a transitional period in their life when not only do they look forward towards their education, career, job security, financial security, marriage, and parenthood; but if the dreams do not come true and there is a failure in achieving their desired goals; they are likely to become depressed. Suicide due to depression become the 4th leading cause of death in this age group.[4,5] Females of this age group are likely to become a mother and it is found that 10% of women during their pregnancy or in their post-partum period suffers from depression.[6]

In India, the prevalence of depression in young adults is 1.6% (Males–1.2%, Females-2%). The overall prevalence of depression in India is 2.68%.[7] Accurate diagnosis of depression remains a significant challenge in clinical practice. Identifying objective biomarkers for depression is crucial for

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improving its diagnosis, prognosis, and treatment outcomes. To address this, researchers have focussed on identifying objective biomarkers that can aid in understanding the neurobiological underpinnings of depression.

One of these biomarkers is P300 event-related potential (ERP), a measure of cognitive processing that reflects the brain's response to stimuli. The P300 is a positive deflection in the event-related potential typically observed around 300 milliseconds when a person is presented with a stimulus, such as sound and is asked to respond to it. P300 is elicited by infrequent or task-relevant stimuli, making it an ideal marker for cognitive functions affected in depression.

Numerous studies have reported alterations in P300 parameters in individuals with depression. One consistent finding is a reduction in P300 amplitude.[8-11] Decreased amplitude has been associated with cognitive impairments, including attentional and working memory disturbances. Additionally, prolonged P300 latency reflecting delayed neural processing has been observed in depressed individuals suggesting impaired information processing speed.[12]

The neurobiological mechanisms underlying P300 changes in depression are complex and multifaceted. Dysregulation of serotonin and noradrenaline neurotransmitter systems has been implicated, as these play crucial roles in cognitive processing and mood regulation.[13] The hypothalamic-pituitary-adrenal (HPA) axis dysregulation, a key component of the stress response system, has also been linked to P300 alterations in depression.[14] Furthermore, neuroinflammation and oxidative stress may contribute to neural dysfunctions leading to P300 changes.[15]

This study provides an overview of P300 changes in depression exploring its potential as a valuable tool for diagnosis of depression based on specific cognitive deficits.

MATERIALS AND METHODS

This study was conducted in the Department of Physiology, and Department of Psychiatry, IGIMS, Patna from December 2022 to April 2023.

Participants:

Cases - 42 patients7 of age group (18-26) years4 (Male – 20, Female –22) with depression were recruited from outpatient, Department of Psychiatry, IGIMS, Patna. The diagnosis of depression was made as defined by 2013, the fifth edition of the American Psychiatric Association's Diagnostic and Statistical Manual (DSM-V)1,2.

Only newly diagnosed patients with depression who have not started antidepressant therapy were included. Subjects with substance abuse, auditory defects; any systemic illness, metabolic disorder or medication known to affect cognition are excluded.

Controls – 89 non-depressed volunteers matched for age, BMI, and sex proportions (Male – 43, Female – 46) with no reported medical conditions known to affect cognition or having auditory defects were included.

The research participants were measured for weight, height, and body mass index was calculated from the collected data. Height was measured by a portable stadiometer (Precision Model, Prime Surgical, New Delhi, India) to the nearest 1 mm. Weight is measured by Omron digital weighing scale HN 300T in kilograms.

P300 is recorded by the MEP Neurosoft 4 machine and analysed by Neurosoft Neuro-MEP.NET software in the Neurophysiology laboratory of IGIMS, Patna on an auditory oddball paradigm in which two types of tones were presented to the participants through a headphone (TA-01) with alternating polarity. Significant stimulus is represented by 2KHz tone and non-significant stimulus is represented by 1 KHz tone, both of 85 dB sound pressure level. A total of 100 stimuli were applied during each test. Subjects had to recognize the significant stimuli and react to them. Electrodes were placed on the scalp as per the international 10-20 system - Ground at the forehead (Fpz), Active at Vertex (Cz), and Reference was placed at the right Mastoid (M2) by using Weaver & Company Ten 20 conductive Neurodiagnostic Electrode paste. The recording sites were cleaned with Weaver & Company Nuprep Skin Prep Gel before applying electrode paste. The skin-to-electrode impedance was kept below 5 K ohm. Signals were filtered with 35 Hz high-pass and 0.5 Hz low-pass filters. The artefact rejection threshold was 500 µV.

Statistical Analyses

The arithmetic means and standard deviation (SD) of anthropometric and P300 parameters of both cases and the control group is calculated. The chi-square test is used for the comparison of gender distribution between the case and control groups. The significance level, or p-value, is calculated using the unpaired t-test. The p-value less than 0.05 ($P<0.05$) is taken as statistically significant and the p-value less than 0.0001 ($p<0.0001$) is taken as statistically highly significant. All statistical analyses were performed using SPSS26 (IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp).

RESULTS

42 newly diagnosed patients suffering from depression of age group (18-25) years (Male – 20, Female – 22) who have not started antidepressant therapy and 89 non-depressed volunteers (Male – 43, Female – 46) matched for age, BMI and sex proportions were studied.

The anthropometric parameters of the participants are shown in [Table 1]. P300 findings are summarized in [Table 2].

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There is no statistically significant difference found in age (p=0.8772), weight (p=0.8598), height (p=0.1897), BMI (p=0.2226) and gender (p=0.9407) between case and control groups.

Table 1: Anthropometric comparison between Case (Depression) and Control subjects

	Case	Control	
Parameters	Mean + SD	Mean + SD	p
Age (Years)	21.79 + 2.05	21.85 + 2.08	0.8772
Weight (Kg)	62.48 + 10.91	62.79 + 8.54	0.8598
Height (meters)	160.20 + 8.18	162.08 + 7.34	0.1897
BMI (kg/m2)	24.82 + 3.41	24.17 + 2.52	0.2226
Gender (M/F)	20/22	43/46	0.9407

* SD=Standard Deviation, BMI=Body Mass Index, M=Male, F=Female

Among the auditory P300 parameters; P300 latency (p<0.0001) is found significantly increased and P300 amplitude (p=0.0007) is found significantly reduced in patients with depression when compared with healthy control subjects.

Table 2: Auditory P300 parameters comparison in Case (Depression) and Control groups

	Case n=42	Control n=89	
P300 parameters	Mean + SD	Mean + SD	p
P300 latency (ms)	353.62+16.72	306.58+12.36	<0.0001
P300 amplitude (mV)	9.82 + 1.82	11.20+2.24	0.0007

* SD=Standard Deviation, ms=millisecond, mV=microvolt, n=no. of subjects

DISCUSSION

In our study, we found a highly significant increase in P300 latency in the group of young adults with depression when compared to the group of healthy young adults taken as control (p<0.0001). This finding of our study coincides with the findings of Tripathi SM et al. who also found an increase in P300 latency in depression.

The second finding of our study is a reduction in P300 amplitude in the group of young adults with depression when compared to the group of healthy controls (p=0.0007). This study of our study coincides with the findings of White EJ et al., Santopetro NJ et al. and Gangadhar et al. who also found a reduction in P300 amplitude in cases of depression.

CONCLUSION

P300 alterations in depression provide valuable insights into the neurophysiological mechanisms underlying the disorder. The observed reductions in P300 amplitude and prolonged latency reflect cognitive impairments associated with attention and information processing. Incorporating P300 as a biomarker in clinical practice has the potential to improve diagnostic accuracy, predict treatment response, and guide personalized interventions.

Limitations

Despite the promise of P300 as a biomarker for depression, several challenges exist. Variability in study designs, P300 paradigms and analysis techniques can complicate data interpretation and limit cross-study comparisons. The influence of confounding factors such as medication use, comorbidities, and demographic variables should also be carefully considered. Future research should aim for standardized protocols and larger sample sizes to enhance reproducibility and generalizability. Longitudinal studies are necessary to establish P300 alterations as predictive biomarkers and elucidate their dynamics throughout the course of depression and treatment.

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Ethics Approval

The Institutional Ethical Committee (IEC) of IGIMS, Patna approved the study with the approval letter 816/IEC/IGIMS/2022.

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Conflicts of Interest

There are no conflicts of interest.

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