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Electroencephalogram of Young Healthy Individuals during and After Seated Rotatory Chair Activity

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Abstract

Physical activities are neurally controlled functions. In the study, the brain waves of apparently healthy individuals during and after seated rotatory chair activity were recorded through electroencephalography. 12 apparently healthy young adult individuals averaging 17.5years were recruited for the study. Electroencephalographic (EEG) waves were recorded with the aid of Powerlab 26T. Electroencephalographic recordings were conducted at baseline (sitting) position as well as during and immediately after seated rotatory chair activity. During the rotatory chair activity, alpha wave frequency was significantly reduced when compared with baseline but beta wave was unchanged. Beta wave frequency was reduced significantly after the activity but alpha wave was unaffected. There was also a significant increase in alpha/beta ratio after the activity in conclusion, rotatory chair activity was characterized by a decrease in alpha wave frequency during spinning onset and decreased beta wave frequency and increased alpha/beta ratio after the activity.

Keywords: Electroencephalogram, Rotatory chair activity, Beta wave, Alpha wave, Alpha/Beta ratio

Introduction

Brain is a principal organ that plays critical roles in the control and coordination of all body activities either spontaneously or in response to internal and external stimuli. During body activities, changes occur in brain activities. Since brain is an excitable structure, brain activities are in form of electric impulses that consist of resting potential, depolarization and repolarization [1,2]. Electroencephalography, as a technique, measures the electric activities into an understandable language 'electroencephalographical waves. For instance, alpha waves (7Hz-12Hz) represent spontaneous thalamic reticular discharges concentrated on the occipital cortex and prominent when visual cortex is inactive (i.e., relaxed wakefulness with eye closed). Theta waves (4Hz-7Hz) are spontaneous discharges produced by CA-3 region of the hippocampus as well as dentate gyrus and entorhinal cortex and are believed to be essential for long term potentiation and memory consolidation. Beta waves (12Hz-30Hz and delta waves (1Hz-3Hz) represent active and inactive cortical neurons respectively. During deep sleep, the cerebral cortex is less responsive to stimuli paving the way to least frequent brain waves known as delta waves. On the contrary, cortical neurons are active during wakefulness and alertness and mental activities [3].

Rotatory chair activity is one of the several bodily activities that elicit changes in body functions. As an exercise program, rotatory chair activity has fondly been utilized for limiting the frequency and risk of falls, strengthening muscles, improving blood flow and cardiorespiratory functions and keeping joints active and lubricated. In old age, rotatory chair exercise helps in improving posture and burning abdominal fats. Advantage of rotatory chair activity when compared to other exercise programs is that it is a low impact activity and less strenuous and this makes it cheap and economical, simple, convenient and accessible, versatile, comfortable and adaptable [4,5]. As far as the brain is concerned, rotatory chair activity has influence. As a matter of fact, rotary chair activity is a component of vestibular test panel. Discovered by Robert Bárány in 1907, the test involves rotation of a seated patient about the cephalo-caudal axis. It evaluates the vestibulocular reflex during rotational stimulation of the horizontal semicircular canals [6].

In a study by four developmentally retarded children were subjected to motor driven rotatory chair at 17 rpm for 600 seconds over 2 weeks [7]. There was vestibular stimulation induced changes in motor and reflex functions. Noisy galvanic vestibular stimulation was shown to influence encephalographic waves by [3]. When 10 healthy participants were stimulated through imperceptible currents at 10, 26, 42, 58, 74 and 90% of sensory threshold, there was a mild suppression of gamma power in

lateral regions after stimulation which was followed by delayed rise in beta and gamma power in frontal regions 20–25 s after cessation of stimulation. A study by utilized electroencephalogram as well as eye-tracking glasses to track brain activity and eye movements in 23 volunteers who were exposed to somatogyral illusion in a seated rotatory chair. A statistically significant decrease in theta power over the left frontal channels was observed during illusion [8].

In the previous studies it has been shown that alpha wave frequency increased during prolonged right leg orthostasis [9]. Pre-exercise ingestion of 1L of water reduced exercise induced rise in alanine transaminase, aspartate transaminase, alkaline phosphatase in mildly active male participants [10]. During post-exercise orthostasis, theta wave amplitude was lower with male exhibited lower theta wave than females [11]. Nocturnal push up for 1 week was shown to reversibly increase peripheral oxygen saturation in young adult volunteers [12]. Sport aversive female students were shown to exhibit lower cardiovascular recovery when compared to sport aversive male students [12]. Sudden switch from sitting to standing position caused reduction in alpha wave frequency and reduction in alpha/beta ratio [13]. The aim of the study was to determine the effect of rotatory chair activity and cessation on basic electroencephalographic waves in males.

Materials and Methods

Study Design

The study was conducted in the Technologically Enhanced Laboratory unit of the Department of Physiology, College of Medical Sciences, Edo State University Uzairue, situated in Etsako West Local Government Area of Edo State, Nigeria.

Subjects

12 apparently healthy young adult individuals (17.5years) were recruited for the study. A well-structured questionnaire was administered to rule out those with medical history of musculoskeletal, respiratory, cardiovascular, kidney, hepatic and metabolic diseases or anatomical deformities. History of smoking, alcoholism and caffeine and any form of medication was also taken. Medical examination and physical activity status were also done.

Inclusion Criteria

30 young adult individuals were recruited for the study through respondent driven sampling. Written consent was gotten from each subject and a well-structured questionnaire was administered to rule out those with medical history of respiratory diseases, cardiovascular, kidney, hepatic and metabolic diseases or anatomical deformities. History of smoking, alcoholism and caffeine and any form of medication was also taken as previously reported (14,15,10).

Medical examination and physical activity status evaluation were also done. Physical examinations were also done and those that were not medically fit were disqualified. For instance, individuals with musculoskeletal abnormalities, high blood pressure, among others were ruled out as was previously done.

Seated Rotatory Chair Activity

During the seated rotatory activity, the subjects with EEG electrodes attached to their scalps were instructed to sit inside a rotatory chair. The chair was spun at the rate of 1 rotation/4second for 3 minutes singly. EEG waves were recorded during and immediately after the seated rotatory chair activity.

Measurement of Electroencephalographic waves

Electroencephalographic (EEG) waves were recorded with the aid of Powerlab 26T (Adinstruments PTY, Australia). As indicated in the manual, both white and blue marked electrodes were connected to the left and right side of the frontal part of the skull while the black electrode was attached to the occiput. Electrodes were held in place by means of electrode pads. As part of the measures aimed at preventing artifacts, ambient noise interference was avoided.

Electroencephalographic recordings were conducted at baseline (sitting) position as well as during and immediately after seated rotatory chair activity. Alpha/beta ratio was calculated by dividing alpha wave frequency by beta wave frequency.

Statistical Analysis

Statistical analysis was conducted using Statistical Package for Social Science Students (SPSS) 23. Statistical test was done using Analysis of Variance (ANOVA) and student t test. Statistically significant difference was accepted at $P<0.05$.

Results

Effect of Rotatory Chair Activity on Alpha Wave Frequency

Figure 1 shows the effect of rotatory chair activity on alpha wave frequency. During rotatory activity, there was a significant ($P<0.05$) reduction in alpha wave frequency when compared with baseline. Alpha wave frequency was significantly increased after rotatory chair activity when compared with rotatory chair group.

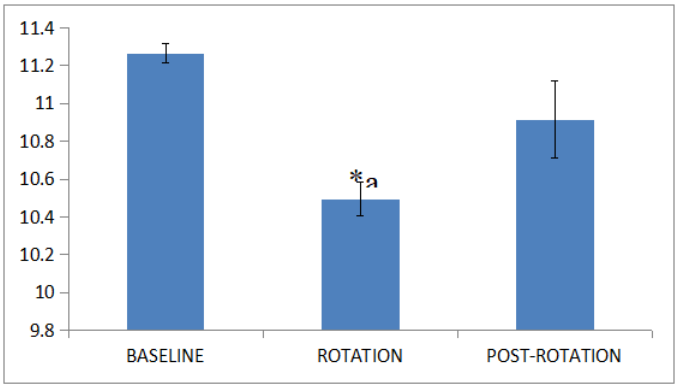

Figure 1: Effect Of Rotatory Chair Activity on Alpha Wave Frequency. '* a' are Significant Difference ($P<0.05$) From Baseline and Post-Rotation Respectively.

Effect of Rotatory Chair Activity on Beta Wave Frequency

Figure 2 shows that there was no significant change in beta wave frequency during rotatory chair activity when compared with baseline. After rotation, beta wave frequency decreased when compared with baseline and rotatory groups respectively.

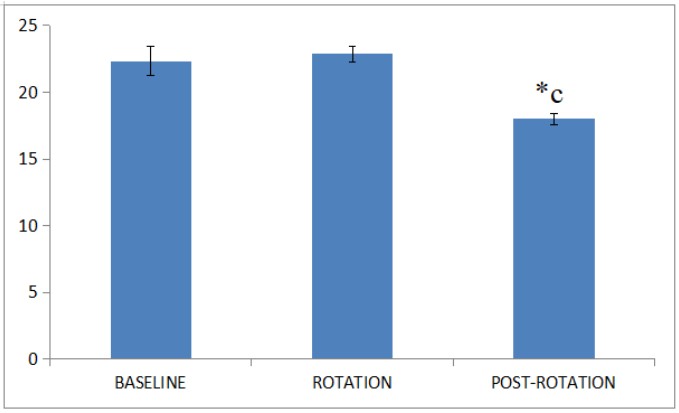

Figure 2: Effect Of Rotatory Chair Activity on Beta Wave Frequency. '* c' are Significant Difference (P<0.05) From Baseline and Rotatory Group Respectively.

Effect Of Rotatory Chair Activity on Alpha/Beta Ratio

Figure 3 shows that there was no significant change in alpha/beta ratio during rotatory chair activity when compared with baseline. After rotation, alpha/beta ratio increased when compared with baseline and rotatory groups respectively.

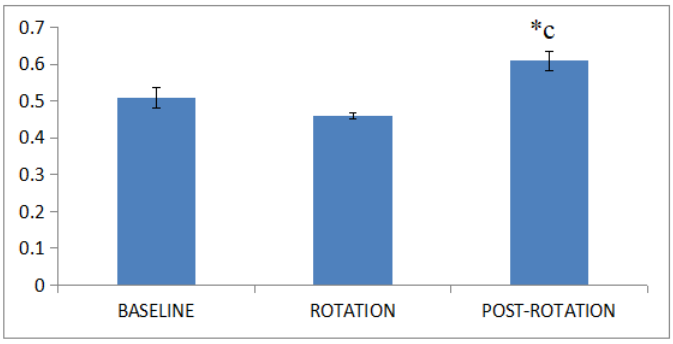

Figure 3: Effect of Rotatory Chair Activity on Alpha/Beta Ratio. '* c' are Significant Difference (P<0.05) From Baseline and Rotatory Group Respectively.

Discussion and Conclusion

Non-invasive analysis of the body functions plays vital roles in the evaluation of the functional status of the body, early detection and diagnosis of medical conditions, effective disease management and prognosis as well as prevention and control of diseases. Electroencephalography as a non-invasive technique has been utilized for the evaluation of electrical activities occurring in the brain from the surface of the body through a system of electrodes. The aim of the study was to record electroencephalogram during and after rotatory chair activity in apparently healthy male individuals.

Rotatory chair activity is a low impact activity making it suitable for the aged as well as people with gait and postural disabilities. Since this form of activity involves spinning of the head, stimulation of vestibular apparatus occurs. In the study, during rotatory chair activity, participants exhibited significantly reduced alpha waves frequency recorded from the occipital lobe when compared with baseline group. Previous works have indicated that in addition to wakefulness with eyes closed, alpha wave frequency tends to be relatively higher during fatigue, dizziness and inactivity and low during increased physical and mental activity [16,17]. Immediately after the rotatory activity, alpha wave frequency was not significantly different from the baseline group but was higher than that recorded during rotatory chair activity.

Beta wave power is known to be more prominent during stress and physical and mental activities [1,4,18,19.] However, in the study, there was no significant difference between rotatory chair activity group and baseline group. Speed of rotation is one of the factors that indicate the hardness of the task and ultimately the beta wave power. Furthermore, after the rotatory task, there was reduction in beta wave frequency when compared to the baseline. Perception of lightheadedness is a prominent experience after undertaking a spinning task. reported a mild suppression of gamma power in the lateral cortical region as well as delayed rise in beta and gamma power in frontal regions of the brain after cessation of stimulation [1].

Alpha/beta ratio is an electroencephalographical index and increase in alpha/beta ratio occurs during fatigue, dizziness and inactivity. Prolonged right leg unipedal orthostasis has been shown to cause an increase in alpha/beta ratio in apparently healthy male individuals [9]. Although there was no significant difference between baseline and rotatory chair groups, alpha/beta ratio increased after rotatory chair activity when compared with the baseline group.

In conclusion, the findings of the study showed that rotatory chair activity was characterized by decrease in alpha wave frequency during spinning onset and decreased beta wave frequency and increased alpha/beta ratio after the activity.

Conflict of Interest

None declared

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