

# ANALYSIS OF MOBILE PHONE RADIATIONS EFFECT ON BETA WAVE OF EEG SIGNAL

RAGHU NANDAN<sup>1</sup>, SANDEEP KAUSHAL<sup>2</sup>

**ABSTRACT:**It is experimentally proved that profuse practice of mobile phone during a great proportion of day-to-day routine outcomes into the poisonous results like genetic harm, tumors, effect in memory, rise in blood pressure and failing the immune confrontation in humans. These impressions can be marked by an electroencephalogram (EEG). This result oriented paper brings the light upon the destructive and lethal consequences upon the human brain due to mobile phone radiation. The aim of this research is to investigate the effects of mobile phone use on left and right ear using electroencephalograph (EEG). Twelve subjects are studied after recording their EEG signals using International 10/20 system of EEG recording. By some earlier research we know that beta upper band (20-30Hz) had dominant effect as compared beta lower band (12-20Hz). Secondly, the total power level of beta waves during mobile phone usage on right ear is more than left ear. This Increased power level of beta waves leads to anxiety, stress and physical & mental discomforts.

**KEYWORD:** Electroencephalogram, human brain, radio frequency, radiations, health penalties.

## I. INTRODUCTION

Regular use of mobile phone since last 20 years has been extremely amplified. As cell phones are skull oriented electronic devices so its worse radiation effects are quickly increasing on the nervous system. After the large surveys upon mobile phone exposure was completed, the shocking results came along the warning that huge portion of daily use of mobile can possibly harm health and resulting into tumors in brain<sup>1,2</sup>,headpain<sup>[3]</sup>,decay in sperm amount and

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effect fertility rate<sup>[4]</sup> and leading to Alzheimer's and attentiveness consequences due to trouble in neural networks due to mobile radiation (MPR). Practically all studies tested throughout this decade is showed with the assistance of electroencephalogram in which the signal is estimated as undeviating linear signal and the examination is guided on the foundation of that, but basically an electric wave from the brain is cannot be predictive. Thenonlinearwaveringandlittlealteration in mental statejiggle the signals. Mobile phones produce the radio frequency electric and magnetic field (RF-EMF) which is a type ofnon-ionizing radiationand in between the range of frequencyfrom 100 - 300 GHz. The GSM mobile can have radio waves of peak power of 2 wattwhileCDMA uses the inferior output power typically below 1 watt. The radiation captivation rate of human body is dignified through Specific Absorption Rate (SAR). The SAR boundarysecure by Federal Communications Commission (FCC) is of 1.6 W/kg, and it is important to know that when SAR >4 W/kg, then potential health hazards may occur.

## II. EFFECTS

Plentiful scientific experimentations have examined probable symptoms on healthiness due to mobile phone radiation.



*Fig. 1: Effects of Mobile radiation<sup>[15]</sup>*

Recent assessment was published in year 2007 by SCENIHR, who concluded that exposure to Radio frequency fields is implausible to tip to raise in cancer. The scientists of the National Institutes of Health (NIH) and the Brookhaven National Lab (BNL) through the assistance of medical paraphernalia known as positron emission tomography (PET) have evidenced that radiation from fifty minutes cell phone experience can upsurge Glucose Metabolism of brain<sup>5</sup>.

### III. EFFECTS ARISES DUE TO RADIATION CAPTIVATION

Body do captivates a quantity of radio waves produced through mobile phone, the radio waves through a GSM sets are typically lower than a watt<sup>[6]</sup>. As the maximum power amount produced by mobiles is controlled by the mobile phone standard as well as by regulatory organizations in every country. In practically all systems the mobile phones along with its base station frequently checks out the reception excellence along with the signal power with respect to which the power level is intensified or reduced, this whole procedure is done within a definite span, to provide accommodations numerous circumstances like such as inside or outside of big buildings, proceeding road moving vehicles<sup>[7]</sup>. As it is previously specified that the radiation captivation rate of human body is dignified by Specific Absorption Rate (SAR), which is standard by Federal Communications Commission (FCC) and this is of 1.6 W/kg. Europe consumes limit of 2 W/kg which is middling over a capacity of 10gm to that of tissue. As the value of SAR is enormously depend on the averaging volume. Deficient information about this averaging volume, the comparisons amongst several measurements is simply not possible to be made. Therefore the European 10-gram ratings should be calculated between themselves, similarly American 1-gram ratings should be calculated amongst themselves. It is very necessary to note that when SAR value becomes greater than 4 W/kg, the potential health threats may occur.

### IV. BLOOD - BRAIN HURDLE EFFECTS

Handful researches of Lund University have recently experimented the effects arose in rat brain because of being in contact microwave radiation and the result they found was the outflow of albumin into the brain by the infused blood brain hurdle<sup>[8, 9]</sup>, founding that if it could so

harmfully effects the rat brain then what might be happen harmfully wrong with the human brain.

### V. CONSEQUENCES ARISES BECAUSE OF ELECTROMAGNETIC RADIATION

Electromagnetic radiation are classified into 1st ionizing radiation and then 2nd is non-ionizing radiation, knowing is it accomplished of ionizing the minute atoms and violation off chemical links or not. The dielectric heating system is a result on biology happening due to electromagnetic fields. Magnetic fields initiation into the circulating currents all the way through the body where this tough magnetic fields are unswervingly reliant on the intensity of the effecting magnetic field and triggering nerves and muscles to rouse resulting into harmful effect on biological processes.

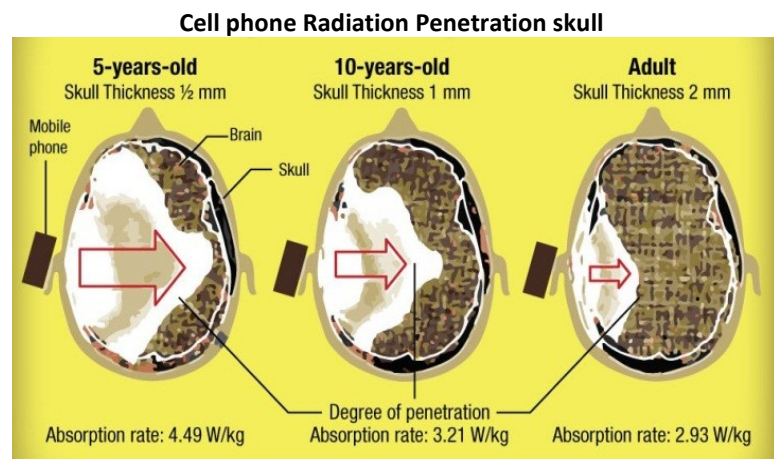


Fig. 2: ELECTROMAGNETIC RADIATION EFFECT ON BRAIN<sup>[10]</sup>

- I. Captivation power of children is more.
- II. Temporal lobe is not as deadly as brain tumor.
- III. Children's cells are reproducing more quickly than adults.
- IV. Children's immune system is not as well developed as adults.
- V. Longer potential for life-time exposure for children than adults.

This effect is a series of events containing exposure to radiations of EM and which when captivated by body modifies the arrangements of biological field, resulting shift in the functioning activities of cell and lastly resulting in certain hazardous disease. Due to rise in mobile users all over world, the level of electromagnetic radiation likewise

increase which enhances up more danger. Current experimental studies have exposed that the children are more affected by these telecommunication radiations. Fig. 1 shows evidently regarding electromagnetic fields that they are probable to penetrate into the brain of little children extreme more severely as related to adults. Truly, for the reason that children's thinner skulls, lesser size of brains and lenient brain tissue; they are very defenseless from being damage from these cell phones. This must be taken into account that this difficulty of EM radiation is necessary to be solved before it's too late to inverse its influences as they also affect the genes of humans.

### VI. EEG, ITS MATERIALS ALONG WITH METHODS AND EXPERIMENTAL SETUP

EEG scripts scalp records of electrical movements inside human brain or in exact words it measures the brain waves produced from nerve cells in cortex of brain whose activity is presented on the screen of an EEG machine in the procedure of waveforms of inconsistent frequency and amplitude measured in micro voltage. The neurons activates while generating the synaptic currents inside the dendrites, and this current creates a magnetic field which are computable with the assistance of electromyogram (EMG) machines where secondary electrical field above the scalp are computable with the assistance of EEG systems. The current which is formed in the brain naturally by thrusting of +ve ions of (Na<sup>+</sup>), (K<sup>+</sup>), (Ca<sup>++</sup>), and the -ve ion of (Cl<sup>-</sup>) through the neuron crusts concentrating by the membrane potential, potential of 60 to 70 mV with -ve polarity is logged below the cell body membrane. This potential oscillates with distinctions in synaptic activities.

according to their frequency, amplitude, shape and the sites on the scalp of record. This entire information concerning waveform frequency and its shape is joined with that of the patient's age, state of sleep, and location on the scalp to accomplish importance. Fig -2 signifies the experimental method used in this study and the stages executed to gather data, its preprocessing, then feature abstraction and at the end analysis.



Fig.4: Electroencephalography machine with connector panel<sup>[17]</sup>

Electroencephalogram (EEG) system comprises numerous electrodes and for each unlike channel there is a typical of differential amplifiers which are tailed by filters providing adjustable settings, stimulations, sampling frequency and few are armed with facility of advanced signal processing tools for signals.

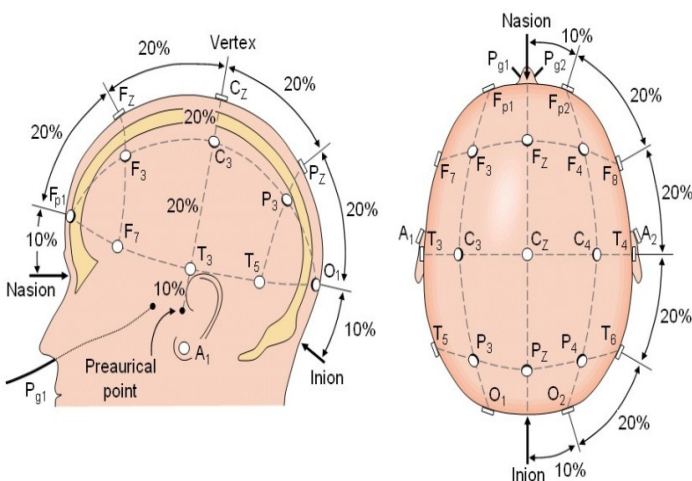


Fig.3: 10/20 Electrode system for EEG acquisition<sup>[16]</sup>

The waveforms of EEG are in general categorized

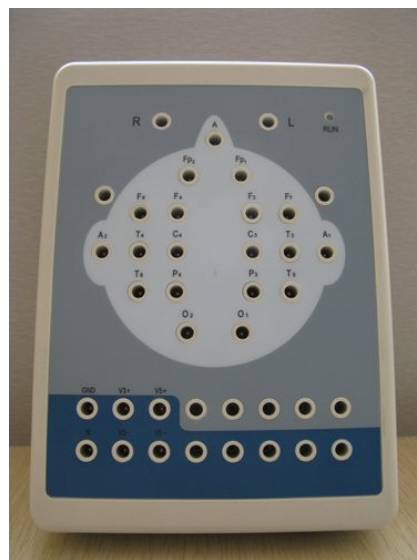


Fig.5: EEG machine connector panel<sup>[18]</sup>

It is very significant to get accurate EEG electrode placement in direction to safeguard right position of electrodes with respect to cortical zones so they can be

consistently and exactly maintained from one to another. In fig 3 the complete machine unit of Electroencephalography(EEG) is shown along with different modules of it i.e. "Control Panel", Connector Panel ", Software preface of the machine . All above mentioned units of machine are important but while dealing with EEG we must have core knowledge of connector placement of connector panel, as I am using 10/20 standard machine which has 21 connectors. The 10/20 system or International 10-20 system is an internationally recognized method to describe and apply the location of scalp electrode in the context of an EEG test or experiment. This method was developed to ensure standardized reproducibility so that a subject's studies could be compared over time and subject could be compared to each other. The "10" and "20" refer to the fact that the actual distances between adjacent electrodes are either 10% or 20% of the total front-back or right-left distance of the skull. Each site has a letter to identify the lobe and a number to identify the hemisphere location. The letters F, T, C, P and O stand for frontal, temporal, central, parietal, and occipital lobes, respectively. Note that there exists no central lobe; the "C" letter is used only for identification purposes. A "z" (zero) refers to an electrode placed on the midline. Even numbers (2, 4, 6, and 8) refer to electrode positions on the right hemisphere, whereas odd numbers (1, 3, 5, and 7) refer to those on the left hemisphere. In addition, the letter codes A, Pg and Fp identifies the earlobes, nasopharyngeal and frontal polar sites respectively.



*Fig.7: Subject-1 setup using mobile on right side*

Now in this second case which is shown by fig 7 we are taking readings of subject by connecting mobile which is during its call operation means online or we can say during running call for about 15 minutes so that to take an average of all to get our result exactly by connecting on its right side.



*Fig.8: Subject-1 setup using mobile on left side*

Now in this third case as shown by fig no 8 i are taking readings of subject 1 by connecting mobile on left side which is during its call operation means online or we can say during running call for about 15 minutes so that to take an average of all to get our result exact ally from left side as we have done previously.



*Fig.6: Subject-1 setup with green blink without using mobile*

In above Fig6 of subject1 represents that this is the normal case when we just take simple readings on subject without any sort of radio frequency component connected to its head so that at last we get the simple EEG fig as output. Our main work of concern starts from hereafter of this pattern by which at last we will compare it with other two readings of results output.



*Fig.9: Subject-2 setup with green blink & without using mobile.*

To make our results more and more exact I have also take 12 subject to form my data which I need, as shown in fig 9 the whole process of gathering data is repeated.



(a) (b)

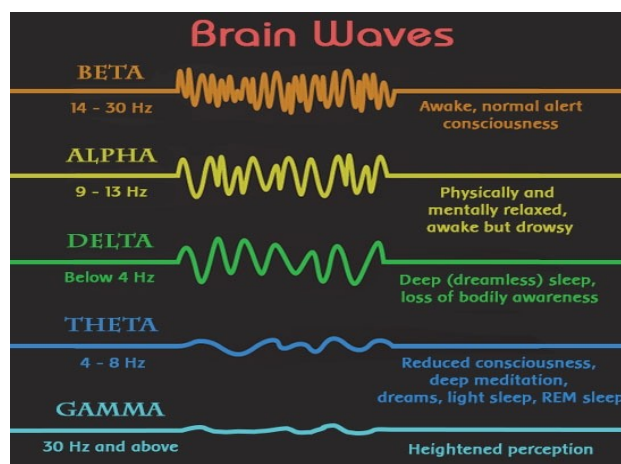
**Fig.10:** Subject-2 setup using mobile on right side & left side

So in fig 10 (a), (b) shows the above mentioned process to get results from left and right side of subject by EEG. To gather our data I have taken three cases i.e. 1<sup>st</sup> one is we take reading of EEG for 15 minutes without using mobile so that this may be considered as normal case, in 2<sup>nd</sup> attempt I will take reading of subject while using mobile on his left side with in call or during call is running & in 3<sup>rd</sup> case I will repeat this whole operation with right side and in the last all the three cases are considered and compared on the behalf of their Power Spectral Density.

#### VII. SELECTION OF BETA WAVES FOR COMPARISORM

Beta waves (12-30 Hz) are the brain waves of our normal waking consciousness, of our outward attention, of logical conscious and analytical thinking. High frequency beta (“splayed beta”) is seen with restlessness, stress, anxiety, panic or whiles our inner critic or commentator is active. Splayed beta can be differentiated from the low frequency beta of the awakened mind, when thinking feels clear, alert, creative and to the point. So while using mobile these are main waves which I have to be taken to consideration. Furthermore the Beta waves can be differentiated as Beta Low (12-20 Hz), and Beta High (20-30 Hz). So to form my complete data chart I have taken complete reading from 12 Hz to 30 Hz and then I have to differentiate them from Beta high and Beta Low. As shown in fig no 11 the description of all the brain waves are shown, which contain Beta, Alpha, Delta, Theta, Gamma. In starting of

this context I have mentioned the reason why I have chosen only Beta waves to compare my result.

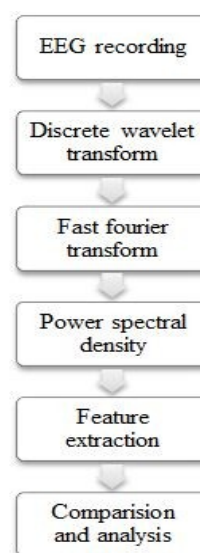


**Fig.11:** Description of Different Brain Waves<sup>[19]</sup>

On the basis above mentioned data I have selected beta waves to be considered for my criteria of comparison to be analyzed for radiation effect on Brain.

#### VIII. METHODOLOGY

The working flow diagram is shown below in fig no 12, which describes each and every step preformed during-



**Fig.12:** Flow Diagram of Experiment

-gathering and comparing data followed by feature extraction and result comparison analysis. To extract

different Frequency Bands I have employed Discrete Wavelet Transform which select some portion of complete Raw EEG signal and gives us a plot of concerned frequency. After that the signal we have is combination of time and frequency, & to get signal only in Time domain I have employed Fast Fourier Transform. And in last I calculate Power Spectral Density which describes the Power contained in any frequency component, to get Power from PSD I just multiply PSD with Concerned Bandwidth.

**Power = PSD\* Bandwidth**

As above mentioned the calculated power can be further divided in to two bands as Power in lower Beta (12-20HZ) band and Power in Higher Beta band (20-30 HZ).

**IX. RESULT COMPARISION**

In my complete paper mainly i want to compare three cases of mobile radiation effect i.e. Gathering beta waves by EEG signal when not using mobile, after than again new reading by using mobile on left side and in last case when using mobile on right side of head.

*Table.1: Power calculations for three cases in beta lower and beta upper band.*

Subjects	Normal case		Mobile on left ear		Mobile on right ear	
	PL	PU	PL	PU	PL	PU
Subject1	1.51	7.84	1.18	1.67	2.45	2.98
Subject2	5.01	5.73	1.17	2.22	2.3	3.48
Subject3	3.95	5.62	2.7	1.95	1.27	4.63
Subject4	2.62	5.37	1.87	1.12	2.84	1.53
Subject5	2.2	5.24	1.54	2.61	1.67	3.42
Subject6	1.4	2.41	3.33	4.68	3.42	8.3
Subject7	2.32	3.47	4.68	1.61	1.28	4.01
Subject8	2.01	12.03	3.1	3.57	6.05	8.12
Subject9	6.52	8.01	4.2	4.09	1.17	8.99
Subject10	8.02	3.07	5.1	3.2	4.5	5.8
Subject11	2.31	1.04	3.03	7.51	1.61	1.63
Subject12	6.28	8.95	4.01	2.53	9.43	1.54

*\*PU=power in upper band; \*PL= power in lower band; all values in microwatts*

The performance of higher-frequency components (20-30Hz) suggests that the alertness level of the subjects was higher when they used the mobile phone on right ear and left ear in contrast to without the use of phone. So,

alertness or awareness of the brain increases with mobile phone usage. The total power of the beta waves in case of mobile used on right ear was more than when it is used on left ear. Thus, it can be concluded that using mobile phone on right ear can lead to physical and muscular discomfort that include stress, anxiety and other physical and mental effects.

**X. CONCLUSION**

Power of upper band in case of mobile phone usage on right ear is approximately 10-50% more in majority of the cases in comparison to left ear phone usage. Total power (beta upper band + beta lower band) in case of mobile usage on right ear was found approx. (1.5- 2) times as compared to left ear in more than 60% subjects. Our main motive of this paper is to bring this very delicate matter of brain health affected by mobile radiations in light, in this paper we shown this by considering Beta waves which are affected. It must be noted that soon some precautions must take all over the world wide. As brain is the most important part of human and it this gets effects worldwide it might can effects very harmfully the coming generations.

**XI. ACKNOWLEDGMENT**

The work presented in this paper is the outcome of thesis done by the first author during Master of Technology (Electronics and communication Engineering) Degree under the guidance of second author. The authors are thankful to faculty and staff of Amritsar College of Engineering & Technology, Amritsar, Punjab (India) for support and encouragement.

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