

A METHOD FOR COMPUTERISED RECORDING AND ANALYSIS OF HIGH FREQUENCY BIOPOTENTIALS (OSCILLOMETRY)

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(Received on February 28, 2008)

Abstract : Oscillometry records the high frequency electrical activity on the skin surface. These are induced by external ambient electromagnetic radiations, and generated internally by physiological processes. The existence of these surface A.C. oscillations is fundamental to the existence of an electromagnetic field around the human body. Unfiltered electrical and inductive signals are digitally recorded using the computer sound card and audio analysis software. The power and frequency content of the signal is measured. A sound card with a sample rate of 96 KHz enables FFT from 0 to 45 KHz. It can be used to study the electrical response of the body to externally administered electromagnetic radiations. Some of the responses seen during yoga practices are capable of inductive influences.

Key words : high frequency biopotential yoga oscillometry
electromagnetic radiations inductive influences

INTRODUCTION

Skin surface biopotentials arise as a result of internally generated biological electrical activity. Standard biopotential recorders have a frequency response limitation of 1 KHz. High frequency biopotentials have thus been eliminated in order to obtain the EGG, EMG and EEG. The existence of high frequency biopotentials appears controversial and their source and significance rather unknown. The human body as a source of electromagnetic

radiations is fairly disputed. The electrical responses of the body to ambient electromagnetic radiations are difficult to quantify. It is well known that ambient radiations from electrical and electronic appliances induce artifacts in biopotential recordings. The role of higher frequency inductions in the causation of disease is being much researched (1, 6). However, the electrical response of the body to these radiations and the individual variability in this response has not been studied. So far both these phenomena have not been

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studied due to the limitations of recording instruments and that the high frequency components are treated as noise and are therefore suppressed. This paper reports a notebook computer based oscillometry system for recording the electrical activity on the skin surface including the high frequency components. The present suggested method is capable of objectively studying these unexplored areas using relatively low cost equipment. It enables recording, quantification and statistical analysis and therefore opens a new field of research.

METHODS

The instrumental set up used in the present study is a modified and improved form of the equipment used in earlier reported works (2, 3). Skin surface biopotentials are picked up using standard skin surface electrodes. EGG limb electrodes were used in this study. Inductive potentials are picked up using a similar electrode electrically insulated from the skin. The insulated electrode when moved outside the inductive field of the subject picks up ambient inductive voltages. A second electrode connects the skin to the common earth of the instrument. The signal picked up is fed into the stereo line-in audio input of the computer audio recorder. In this study a Conexant HD audio card (sample rate 9600 Hz) is used, with an Audition 3 windows sound driver, installed on a HP Compaq Presario V 6000 notebook. The use of a battery operated notebook computer reduces instrumental inductions. It enables recordings at locations remote from AC power sources or when the mains are switched off. Adobe Audition 3 used in this study is a low cost professional audio recording and analysis

software available on Internet. It is user friendly and is capable of FFT and timed spectral waveform display. The waveform view displays the changes in the power of the input signal with respect to time and appears similar to a dual beam oscilloscope. It represents the summed wave form of the simultaneously co-existent harmonics in the signal. The power of the signal in decibels can be measured at any point of time and the average root mean square power in a selected patch obtained. The 3D spectral view display shows the moment-to-moment changes in the amplitude and frequency content of the signal. The appearance and the disappearance of specific frequencies or band oscillations are noted and can be easily located, and correlated with events and cues. The waveform statistics and FFT data can be transferred to Microsoft Excel and analyzed. The data obtained enables an objective statement of the quantity and quality of the electrical and inductive oscillations on the body (Table I). It can be used to make a multi dimensional statement on the energy status of the person. Shorted input leads reflect the intrinsic system noise. Open electrodes placed in the empty recording booth pick up ambient induction. The amplitude of the 50 Hz signal is the marker for induction from electrical appliances. High frequency signals are picked up from CRO screens and CFL bulbs. Ambient radiations induce changes in the amplitude and frequency content of the Skin biopotentials (Fig. 1). These are reduced when the subject is placed on a cotton rug. The posture and attitude of the subject should be kept the same in the base line and test situation as these can alter the signal. A variety of protocols can be used for the study of two simultaneously occurring

TABLE I: Sorted full range FFT data sheet of biopotentials induced by a CFL Bulb.

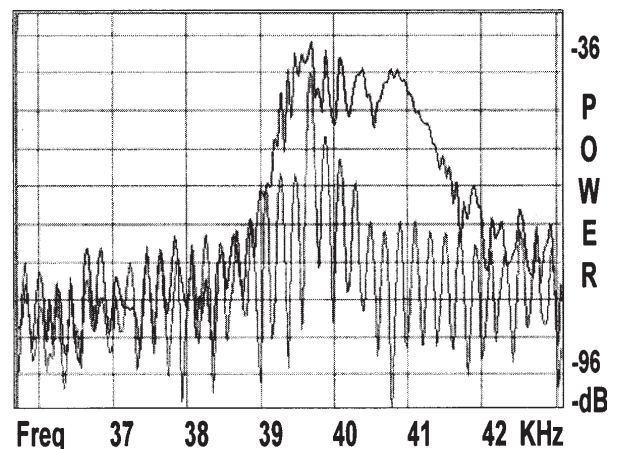
Low (0-1 kHz)		Mid (1-10 kHz)		High (10-20 kHz)		Very high (20-45 kHz)	
Freq Hz	Power -dB	Freq Hz	Power -dB	Freq Hz	Power -dB	Freq Hz	Power -dB
BULB OFF							
47	-45	2531	-65	17953	-69	39656	-43
0	-48	2484	-66	12797	-69	39703	-43
94	-51	2438	-66	13125	-71	39891	-52
141	-56	2578	-66	18000	-72	40078	-55
188	-61	2391	-67	13078	-72	39844	-57
469	-62	2203	-68	12750	-73	39281	-58
234	-64	2672	-68	15375	-73	39469	-58
422	-65	2625	-68	17391	-73	31219	-58
281	-66	2250	-68	17906	-73	40125	-59
844	-68	2297	-68	13313	-74	31266	-60
BULB ON							
47	-45	2391	-68	12797	-67	39563	-37
0	-47	3094	-68	12844	-68	39656	-38
94	-50	3141	-68	17859	-68	39844	-39
141	-55	3047	-68	17953	-73	39469	-39
188	-59	2484	-69	17578	-73	40453	-41
234	-64	2578	-69	12891	-73	40922	-42
469	-62	2438	-69	12000	-73	39891	-42
750	-68	2531	-70	17672	-73	39984	-42
938	-68	2625	-70	17531	-74	40828	-42
422	-63	2672	-70	12703	-74	40969	-43

events like: a) the comparison of electrical and inductive oscillations on the body surface; b) the electrical activity on two different parts of the body; c) the electrical activity from two subjects; d) the electrical response to a monitored electromagnetic challenge and e) the simultaneous Audio recording of chanting and biopotential changes. The yogic variables to be considered in energy flow studies are: human interaction, posture, breathing, chanting and meditation (Fig. 2). Artifacts are recorded from electrical switching, mobile phone buzzers and electrical appliances.

RESULTS

Fig. 1 shows biopotentials induced by the CFL bulb. The subject was seated on a mat with his eyes closed and back facing to the bulb placed 1 meter away. The top linear FFT shows well formed very high frequency potentials. There is a triangular formation

from 39 to 41 KHz with a peak at 39.7 KHz. The peak plateaus from 39 to 41 KHz on



Linear FFT: Top Trace: bulb ON / Bottom Trace: bulb OFF
Shows well formed very high frequency potentials. There is a triangular formation from 39 to 41 KHz with a peak at 39.7 KHz. The peak plateaus from 39 to 41 KHz on switching on a CFL bulb

Fig. 1: Biopotential induced by CFL bulb.

switching on a CFL bulb. The full range FFT data sheet is shown in Table 1. It is obtained by exporting the clipboard values to Microsoft Excel. The 500 most powerful peaks are sorted. The peak frequencies are obtained in the low (0–1 KHz), mid (1–10 KHz), high (10–20 KHz) and very high (20–50 KHz) ranges. The top 10 peaks in each range are arranged in descending order of power in dB. The CFL bulb emits a narrow band of frequencies at 40 KHz. It is seen that in the very high range the band from 39 to 41 KHz gets a significant boost in power when the bulb is switched on. The other frequencies are not significantly altered. In this selection low amplitude high frequency peaks are seen at 13 and 17 KHz. Low amplitude mid frequency peaks between 2 and 3 KHz. Significant Low frequencies are present with peaks at 47 and 0 Hz. The 47 peak is indicative of induction from AC mains and the 0 electrostatic elements. They are not altered on switching on the bulb.

Fig. 2(A) shows the recording of a subject with a headache seated on a straw mat. The electrical mains were switched off to eliminate the ambient electrical inductions. Biopotentials were recorded from the left wrist. Electrical pick up is displayed on the top trace and inductive pick up on the bottom trace. Logarithmic FFT was selected in order to get a better low frequency definition. The subject is (A) sitting on mat in disharmony, a high frequency plateau and very high frequency peaks are seen. On lying down (B) there is blunting of high and very high peaks with elevation of low frequency. This is more evident in the electrical trace (top trace). On taking a deep abdominal breath and holding (C) there is reduction of low frequency activity. The subject then went in to meditation (*Shavasana*) and the trace (D)

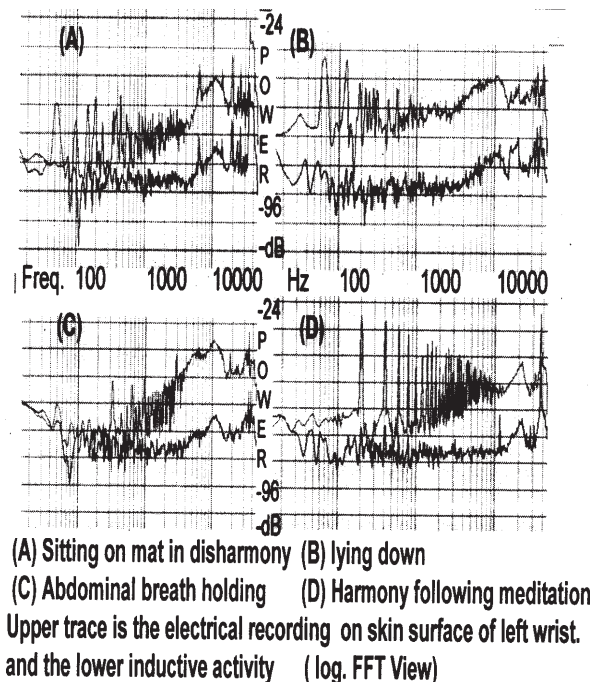


Fig. 2: Progress of meditation with the main switched off.

was obtained. There is abolition of the low frequency activity below 100 Hz with mid frequency domination. The high frequency plateau is now replaced by a distinct peak at 40 KHz. The lower inductive trace shows similar patterns as the electrical in the high and very high ranges. The power of these induced frequencies decrease on removing the probe from the body. The induced 40 KHz peak approximates the electrical peak in power during meditation (D).

DISCUSSION

The proven efficacy of yoga has raised more questions than provided answers. Its mechanism of action has eluded scientific analysis. The need for tools to measure subtle energy (*Prana*) flow has been expressed. Yoga claims to be able to circulate this subtle energy through the body and exchange it with the environment. Motoyama

of Japan (4) demonstrated that trained meditators could cause field effects on copper plates placed opposite the subtle energy ports (*chakras*). Valerie Hunt (5) placed EMG electrodes on energy points and recorded frequencies in correspondence to the *chakras* activated. Mendanha in 2001 (2) observed and recorded changes in the harmonic content of the signal during the practice of meditation. We have consistently observed that Yoga practice and meditation alter the energy status in terms of both power and frequency. When the electrical potentials on the body are significantly elevated, they are capable of inducing electrical changes in the ambience similar in frequency content to the skin electrical activity. Detailed observations on these are being reported in a separate paper. The observation on the capacity of a bulb to induce electrical frequencies demonstrates that the body acts as an antenna and is sensitive to ambient inductive radiations. These potentials have been the bane of electro physiologists but have not been objectively studied. While epidemiological studies abound on the effects of electromagnetic radiations on health (1, 6), data on the electrical response of the body to electromagnetic challenge is not available.

In conclusion, oscillometry opens the field to research the role of very high

frequency biopotentials in health and disease. My studies over the last decade (2) have observed consistent changes during yoga practices which involve the flow of subtle energy. This method is able to quantify and qualify the inductive influence of a person. It establishes the fact that the human body acts as an antenna. Extending the frequency response to the ultra high range will enlarge the scope (6). Multi centric studies under double blind controlled conditions will be required to make definitive statements on normal values and variations.

ACKNOWLEDGEMENTS

I wish to acknowledge the Late Dr. Marcus Devanandan, Professor of Physiology Christian Medical College Vellore. My Professor Dr. K. N. Sharma, who recognized the physiological relevance of my work, and encouraged and guided me to the completion of the project. Dr. P. B Vidyasagar, Professor of Bio-Physics for helping to validate the instrument. Dr. A. D. Shaligram Professor of electronics at the University of Pune, for vital help in completion. Swamy Maheshananda, Chairman Kaivalyadhama Lonavla, for permitting me to do recordings during yoga practice. Shri P. A. Inamdar President MCE society, and the staff and students of the M. A. Rangoonwala dental college, for their help and support.

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