HARMFUL EFFECTS OF 3G AND 4G PENETRATED ELECTRIC FIELD OF MOBILE PHONE HANDSET RADIATIONS ON SKIN OF HUMAN BODY

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ABSTRACT

Mobile phones radiations are transmitted from the mobile phone towers using radiofrequency waves. These radiofrequency radiations received and sent by mobile phones in all directions. The mobile phone radiations were exposed to the human body tissues and were penetrated into it. The exposure of mobile phones radiofrequency fields is generally more than a 1000 time higher than their base stations. There are concerns of mobile phone radiofrequency radiations that could cause health problems. These mobile phone radiations are absorbed by human body can cause health problems. If such mobile phone radiations are high enough, so they cause thermal effects on human body. In this paper we find the harmful distances from the mobile phone radiofrequency waves into skin tissues of human body. This study was done at frequencies 2100 MHz and 2300 MHz and radiated power of 1.5 Watts is taken for this study.

KEYWORDS: Electromagnetic waves, wet skin and mobile phone.

1. INTRODUCTION

Mobile phone radiations are radiofrequency radiations. The effects of mobile phone radiations on human health are the subject of recent study and interest, as the huge raise in mobile phone usage all over the world.[1] The high frequency radiations are penetrated into human body, then power is absorbed it. These non ionizing radiofrequency radiations affect the human health directly and indirectly. The most common complaints due to the power absorption are behavior change, memory loss, headache, discomfort, sleep disruption, depression, irritability, nausea, dizziness, appetite loss, muscle spasms, numbness, altered reflexes, tingling, subjects reported buzzing in the head, light headedness, palpitations of the heart, visual disorders, cardiovascular problems, agitation, etc. Mobile phone waves can damage hair cells between the ages of 16-32 years. These hair cells do not regenerate causing hearing problems in human being. The high frequency radiation effect may increase in temperature of human body tissues is called thermal effect. These effects may cause development and disruption of cell function. The human being tissue could damage due to the inability of body to dissipate the excessive heat. The blood brain circulation is capable of disposing of excessive heat.[2,3]

When a person using mobile phone most of the heating effect will take place at the surface of head causing increase in temperature. The magnitude of increase in temperature is less than the magnitude obtained during the exposure of head with direct sunlight. However the cornea of human eye does not have such mechanism of temperature regulation. Temperature in the internal ear brain etc increases to one degree or more. Head is in the near field of radiation so that most of the heating effect occurs in the head. Typical base station power levels are really low compare to an analog radio or television transmitter that radiates tens or hundreds of kilowatts even megawatts in some cases. Mobile phone base station power is usually limited to ensure that neighboring cells do not interfere with each other, not for health reasons.

Swedish Lund University Researchers have studied the effects of radiofrequency radiations on brain of rat. They found a leakage of albumin into the brain via a blood brain barrier.[4,6] Other groups of researchers have not established these results in vitro cell studies or whole animal studies. But this study on the blood brain barrier was confirmed by H. Allan et.al.[7]

The mobile phone wave transmitted can have an effect not only the general body but more specifically on the male reproductive organs such as effects on count morphology, sperm functions, sperm motility etc. Children have great effect of mobile phone radiations as they absorb more energy than adults from the same phone owing to their smaller head and brain size, thinner cranial bones and thinner skin, lower blood, lower cell volume, more elastic ear, greater conductivity of nerve

cells and the energy penetration of energy are more deeply. Immune system of children is not as well developed as compared to adults; therefore they are less effective against fighting cancer growth than children. Brain tumors are more deadly as compared to temporal lobe. It was found that mobile phone radiations are harmful for women during pregnancy and greater likelihood for spontaneous abortion, congenital malformations and behavioral problems in their children. It also found that the eggs which form the embryo are damage and affect will become apparent after the child reaches puberty.[8] It is seen that children talk on the mobile phone are likely to suffer from cognitive abilities, decline of attention, disruption of memory and diminishing learning increased irritability in the short term and long term hazards include deterioration of the nervous structures of the brain and depressive syndrome.[9]

2 MATERIALS AND METHOD

The emitted radiation around mobile phone handset are spherical wave if we consider phone as point source then spherical wave are called wave front of radius r. Let the mobile phone power is P and the incident electric field is E_0, the radiating power per unit area is represented by the equation.

$$\frac{P}{4\pi r^2} = \frac{1}{2}\varepsilon_0 E_0^2 c$$

$$E_0 = \left[\frac{P}{2\pi r^2 \varepsilon_0 c}\right]^{\frac{1}{2}} = \frac{7.746\sqrt{P}}{r} \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where ε_0 is the permittivity of free space and c is the velocity of radiation. If the mobile phone handsets of power 1.5W radiate the electromagnetic waves, the electric field can be calculated by,

$$E_0 = 9.50/r\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

During transmission of electromagnetic wave inside the biological tissue, field strength reduces due to indulgence then electric field decreases exponentially with distance and is given by the equation,

$$E_z = E_0 e^{(-z/\delta)}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(3)$$

Where E_z is the field inside the depth z, E_0 is the magnitude of field inside the boundary and δ is skin depth. For biological materials skin depth is given by,

$$\delta = (\frac{1}{\omega q})^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$q = \left[\frac{\varepsilon\mu}{2}\left\{(1+P^2)2-1\right\}\right]^{\frac{1}{2}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$\text{Where } P = \frac{\sigma}{\omega\varepsilon} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots... (6)$$

Where σ is conductivity of biological material, ε is permittivity, ω is angular frequency of radiation and μ is the permeability of materials of tissues.

Formula for reference levels for general public exposure to time-varying electric fields with frequency (f) safe frequency range 2GHz to 300GHz is $1.375(f)^{1/2}$, where f is the frequency of electromagnetic waves.[10]
For frequency f=2100 MHz, E=63.0104 V/m
For frequency f=2300 MHz, E=65.94 V/m

Table 1 Induced electric field radiated from the cell phone hand sets.

Distance from cell phone in(cm)	Incident electric field (E_0) in (V/m)
1	950.00
2	475.00
3	316.60
4	237.52
5	190.00
6	158.33
7	135.71
8	118.75
9	105.55
10	95.00
11	86.36
12	79.16
13	73.07
14	67.85
15	63.33

3. DISCUSSION

Mobile phone are normally situated very near to the human body, thus the electric fields are calculated only 1 to 15 cm from the body. Table 1 represents the incident penetrated electric field transmitted from the mobile phone handset is decreased 93.33% from 1cm to 15cm from the body. Table 2 and 3 represents that penetrated electric field is decreased 93.337% in skin due to 2100 MHz and 2300MHz electromagnetic waves frequency as we move from 1cm to 15cm of cell phone from the body.

Table 2. Penetrated electric field inside the skin of human being due to the electromagnetic wave of frequency, f=2100 MHz (3G).

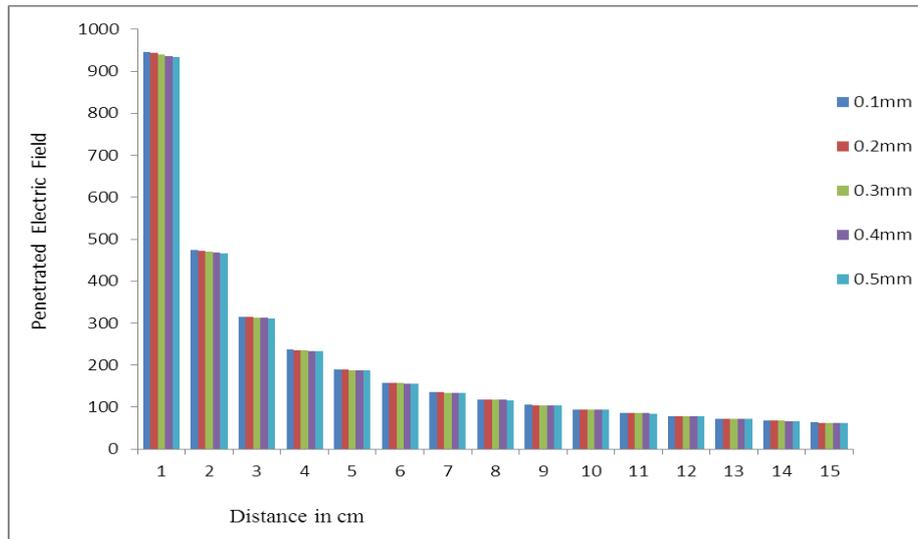| Distance from mobile phone(cm)	Electric field (E_0) (V/m)	Penetrated electric field (V/m) in skin at depth, (mm)				
		0.1	0.2	0.3	0.4	0.5
1	950.00	946.708	943.4275	940.1582	936.9004	933.6538
2	475.00	473.354	471.7137	470.0791	468.4502	466.8269
3	316.60	315.5029	314.4096	313.3201	312.2344	311.1524
4	237.52	236.6969	235.8767	235.0594	234.2448	233.4331
5	190.00	189.3416	188.6855	188.0316	187.3801	186.7308
6	158.33	157.7813	157.2346	156.6897	156.1468	155.6057
7	135.71	135.2397	134.7711	134.3041	133.8387	133.3749
8	118.75	118.3385	117.9284	117.5198	117.1125	116.7067
9	105.55	105.1842	104.8198	104.4565	104.0946	103.7339
10	95.00	94.6708	94.34275	94.01582	93.69004	93.36538
11	86.36	86.06074	85.76252	85.46533	85.16918	84.87404
12	79.16	78.88569	78.61233	78.33992	78.06846	77.79793
13	73.07	72.81679	72.56447	72.31301	72.06243	71.81272
14	67.85	67.61488	67.38058	67.14709	66.91441	66.68254
15	63.33	63.11055	62.89185	62.67392	62.45674	62.24031

Fig. 1: The variation of penetrated electric field inside the skin of human body with depth of 0.1, 0.2, 0.3, 0.4 and 0.5 mm from mobile phone handset at frequency 2100 MHz (3G).

Table 3 Penetrated electric field inside the skin due to the electromagnetic wave of frequency, f=2300 MHz (4G).

| Distance from mobile phone(cm)	Electric field (E_0) (V/m)	Penetrated electric field (V/m) in skin at depth, (mm)				
		0.1	0.2	0.3	0.4	0.5
1	950.00	945.6973	941.414	937.1502	932.9057	928.6804
2	475.00	472.8486	470.707	468.5751	466.4528	464.3402
3	316.60	315.1661	313.7386	312.3176	310.9031	309.495
4	237.52	236.4442	235.3733	234.3073	233.2461	232.1896
5	190.00	189.1395	188.2828	187.43	186.5811	185.7361
6	158.33	157.6129	156.899	156.1884	155.481	154.7768
7	135.71	135.0953	134.4835	133.8744	133.268	132.6644
8	118.75	118.2122	117.6768	117.1438	116.6132	116.085
9	105.55	105.0719	104.5961	104.1223	103.6507	103.1813
10	95.00	94.56973	94.1414	93.71502	93.29057	92.86804
11	86.36	85.96886	85.57949	85.19189	84.80604	84.42193
12	79.16	78.80147	78.44456	78.08927	77.73559	77.38351
13	73.07	72.73905	72.4096	72.08165	71.75518	71.43018
14	67.85	67.54269	67.23678	66.93225	66.62911	66.32733
15	63.33	63.04317	62.75763	62.47339	62.19044	61.90877
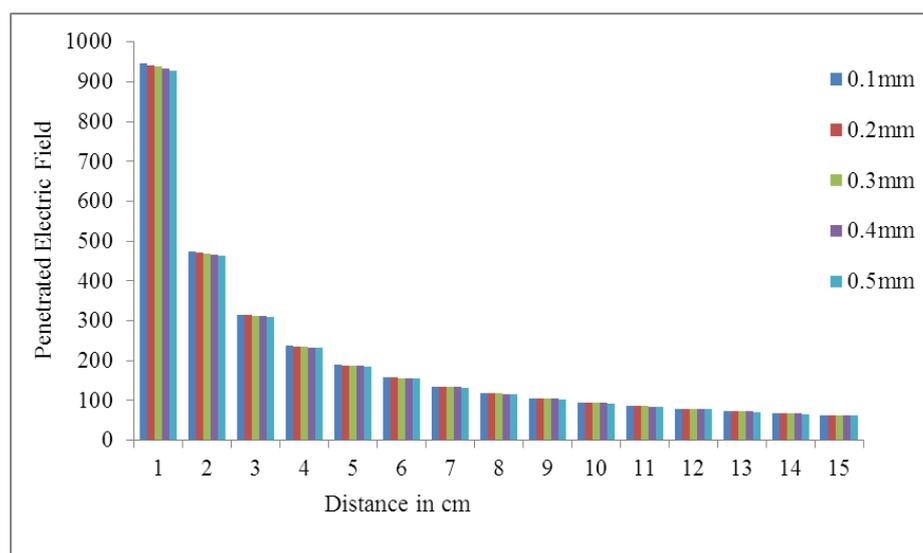
Fig. 2: The variation of penetrated electric field inside the skin of the human body with depth of 0.1, 0.2, 0.3, 0.4 and 0.5 mm from mobile phone handset at frequency 2300 MHz (4G).

4. CONCLUSION

The penetrated electric field inside the body of human body is compared with the international safety standard limits of NRPB, ICNRP, WHO, etc. Normally mobile phone handset radiates 1watt to 2 watts. For the calculation of penetrated electric field the power of the mobile phone handset is taken 1.5 watts. The calculation has been made around the mobile phone hand set from 1 cm to 15cm is given in table 1. In table 2 and 3, penetrated electric field (V/m) inside the skin of human body at 0.1mm to 0.5mm depth due to the electromagnetic wave of frequencies 2100 MHz (3G) and 2300MHz (4G) from 1cm to 15cm distance from the mobile phone handset. The penetrated electric field inside the human body decreases with the increase in distance from. When we bring the mobile phone handset from 15cm towards us, then penetrated electric field increases 93.33% at different depths inside the human body. The fig.1 and fig.2 represents the variation of penetrated electric field with distance of 1cm to 15cm at depth of 0.1mm to 0.5mm inside the human body. The bold data in tables represents harmful for skin of human body. The electromagnetic wave of frequency 2100 MHz, of mobile phone handset are harmful for skin tissue of human body up to up to 15cm at depth of .0.2 mm. The electromagnetic wave of frequency 2300 MHz, of mobile phone handset are harmful for skin tissue of human body up to up to 14cm at depth of .0.2 mm. The penetrated electric field is safe above 15cm distances from the mobile phone handset.

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