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Harmful Effects of Mobile Phone Tower Radiations on Muscle and Bone Tissues of Human Body at Frequencies 800, 900, 1800 and 2450 MHz

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Abstract: The transmitted waves from the mobile phone tower were exposed to the human body and were penetrated into the body where the field was reduced exponentially with depth. In this paper penetration of high frequency electromagnetic waves emitted from a mobile phone tower into human muscle and bone tissues were studied. As the reduction in field was due to absorption of power, specific absorption rate was calculated at frequencies 800,900, 1800 and 2450 MHz and effective radiated power of 20 Watts.

Keywords: Electromagnetic Waves, Muscle and Bone Tissues, Specific Absorption Rate

1. Introduction

So for bio-effects of static and extremely low frequency (ELF) fields have been dealt with. ELF fields are mostly natural and some fields are due to home appliances or factory power lines. The higher frequency field is mostly man made and at various places, sources produce fields of varying intensity. The main source of higher frequency fields is used in communication system i.e. Radio, T.V. microwave transmission and mobile phone communication system. They produce high frequency fields near transmission towers. People living around these towers might be effected because of these fields. At the same time users of receivers may be effected because of field resonance and concentration near them. Interaction of radio frequency fields with human body tissues is a complex function of various parameters. Radio waves in free space are characterized by the frequency, electric field (E) and magnetic field (H) field intensity, their polarization and direction. However, only fields inside the biological bodies and the tissues can interact with them, so it is necessary to determine these electric and magnetic fields for any general quantification and meaningful of biological data [1].

Most of the People are not conscious of mobile phone tower radiations which are very harmful due to electromagnetic radiation exposure. People living near cell tower receive strong signal strength but at the expense of health. It was found that the effective isotropic radiated power from base station antenna is not exceed unity [2].

The electromagnetic field (EMF) can be resolved into four parts, the electric and magnetic fields interact only with each other, the electric and magnetic fields are generated by electric charges, the electric and magnetic fields produce forces on electric charges which move in free space. A particle at rest feels only the force due to the electric field.

The measured rate at which energy is absorbed by the human body when exposed to a radio frequency (RF) electromagnetic field (EMF) is specific absorption rate (SAR). It is also defined as the power absorbed by the tissue per unit mass and is measured in watts per kilogram (W/kg). SAR is usually averaged either over the whole body or over a body tissue. The SAR is determined at the highest certified power level, the actual SAR level of the device while operating can be well below the maximum value. If we measure the specific absorption rate then mobile phone handset should be placed at the head in a talk position. The specific absorption rate value is then measured at the highest location of absorption rate in the entire head, which the mobile phone handset is often as close to their antenna as possible [3]. SAR values increase with the increase of conductivities of human body tissues and decreases with the increase of relative permittivity of human body tissues. Specific absorption rate describes the possible biological effects of RF fields. The high energy radio frequency field exposure causes thermal effects in biological tissues and generates high SAR values. This is called non-thermal effect.

The effect of dielectric values of the human body on the SAR is frequency dependent and orientation of the human body [4]. The maximum increase in temperature of human head tissue is due to specific absorption rate (SAR). At high power density levels, thermal effects occur, some of which can be attributed to heat induced stress mechanisms. The less understood non-thermal effects occur at low radio frequency/microwave power density levels and are not accompanied by any body temperature rise [5]. The effect of mobile phone radiation on human health is the subject of recent interest and study, as a result of the enormous increase in mobile phone usage throughout the world [6] Mobile phones use electromagnetic radiation in the microwave range. Other digital wireless systems, such as data communication networks, produce similar radiation.

Many scientific studies have investigated possible health symptoms of mobile phone radiation. These studies are occasionally reviewed by some scientific committees to assess overall risks. A recent assessment was published in 2007 by the European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) [7].

In India there are nearly 3.75 lakh mobile phone towers and to meet the communication demand, the number will increase to 4.25 lakh towers by 2010 [8]. In many countries, over half the population use mobile phones and the market is growing rapidly. At the end of 2014, there is an estimated 6.9 billion subscriptions globally [9].

2. Calculations of Penetrated Electric Field and Specific Absorption Rate (SAR)

If we consider a mobile phone as a point source, the radiation is emitted around the mobile phone as spherical wave front of radius r. Let the incident electric field be E_0 and power of radiation of mobile phone or around the transmission tower is P, the radiating power per unit area is represented by the equation.

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

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

Where C the velocity of radiation and $\varepsilon_0$is the permittivity of free space

And from the mobile phone tower of power 20W, then electric field is given by

$$E_0 = \frac{34.641}{r} \quad (2)$$

During propagation of electromagnetic wave inside the tissue of biological material, the field strength will further reduce due to dissipation then the electric field decreases exponentially with distance from the boundary and is given by the equation

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

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

$$\delta = \frac{1}{\omega q} \quad (4)$$

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

Where

$$P = \frac{\sigma}{\omega\varepsilon} \quad (6)$$

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

By Pointing vector theorem SAR can be defined as

$$SAR = \frac{\sigma}{\rho}E_i^2 \quad (7)$$

Where E_i is the field inside that material and σ *is* the conductivity of the material, ρ is the density of bio material.

This relation shows that the rate of electromagnetic energy is converted into heat energy through well interaction mechanisms. [10].

3. Standard Values

z= 0.1mm, 0.2mm, 0.3mm, 0.4mm and 0.5mm

At 800 MHz, σ = 0.80864W K^{-1} m^{-1}, skin depth δ = 45.59mm,

At 900 MHz, σ = 0.84465W K^{-1} m^{-1}, of skin depth δ = 43.352 mm

At 1800 MHz, σ= 1.232W K^{-1} m^{-1}, skin depth δ = 28.808 mm,

At 2450 MHz, σ = 1.5919W K^{-1} m^{-1}, skin depth δ = 28.808 mm,

The value of density ρ for skin=1070 kg m^{-3}, for blood=1060 kg m^{-3}, for muscles =1050 kgm^{-3}, for bone= 1520 kg m^{-3}

For frequency of EMW of 10 MHz–10 GHz its safe limit =0.4 W/kg [11].

Table 1. *Reference levels for general public exposure to time-varying electric fields with frequency (f) [11].*

Frequency range	Electric field strength (E) (V /m)
up to 1 Hz	-----------
1–8 Hz	10,000
8–25 Hz	10,000
0.025–0.8 kHz	250/f
0.8–3 kHz	250/f

Frequency range	Electric field strength (E) (V /m)
3–150 kHz	87
0.15–1 MHz	87
1–10 MHz	$87/f^{1/2}$
10–400 MHz	28
400–2,000 MHz	$1.375f^{1/2}$
2–300 GHz	61

For frequency f=800 MHz, E=38.89 V/m
For frequency f=900 MHz, E=40.35 V/m
For frequency f=1800 MHz, E=58.33 V/m
For frequency f=2450 MHz, E=68.059 V/m

For the calculation of penetrated electric field inside the body, the distance of mobile phone tower from the body is taken 1 m to 50 cm for this study skeletal muscle and bone tissues at frequencies 800, 900, 1800 and 2450 MHz and power of radiation of mobile phone tower is 20 W.

Table 2. *Penetrated electric field for muscles at frequency 800 MHz.*

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.535	34.457	34.379	34.301	34.223
5	6.9228	6.9071	6.8914	6.8758	6.8602	6.8447
10	3.4614	3.4535	3.4457	3.4379	3.4301	3.4223
15	2.3076	2.3023	2.2971	2.2919	2.2867	2.2815
20	1.7307	1.7267	1.7228	1.7189	1.7150	1.7111
25	1.3845	1.3814	1.3782	1.3751	1.3720	1.3689
30	1.1538	1.1511	1.1485	1.1459	1.1433	1.1407
35	0.9889	0.9866	0.9844	0.9821	0.9799	0.9777
40	0.8653	0.8633	0.8613	0.8593	0.8574	0.8555
45	0.7692	0.7674	0.7657	0.7639	0.7622	0.7605
50	0.6922	0.6906	0.6890	0.6875	0.6859	0.6843

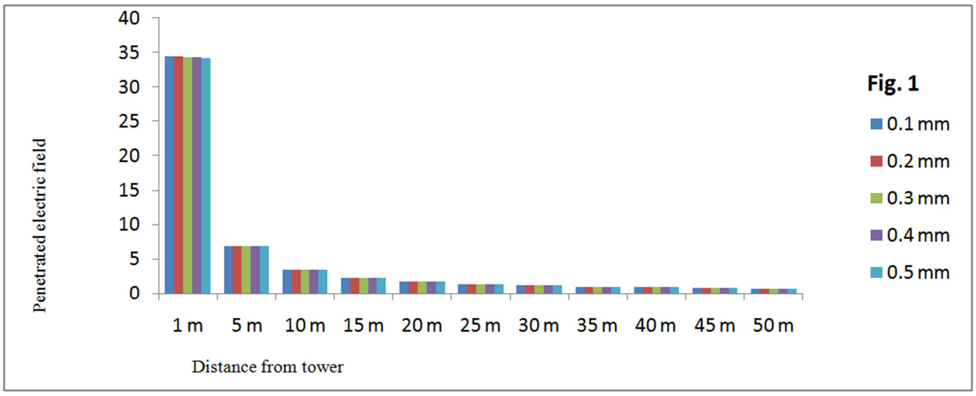

Fig. 1. *Represents a variation of penetrating electric field inside the muscles with the depth of 0.1, 0.2, 0. 3, 0.4 and 0.5 mm from a mobile phone tower at frequency 800 MHz.*

Table 3. *Penetrated electric field for muscles at frequency900 MHz.*

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.605	34.532	34.369	34.288	34.207
5	6.9228	6.9211	6.9064	6.8739	6.8577	6.8415
10	3.4614	3.4605	3.4532	3.4369	3.4288	3.4207
15	2.3076	2.3070	2.3021	2.2913	2.2859	2.2805
20	1.7307	1.7302	1.7266	1.7184	1.7144	1.7103
25	1.3845	1.3842	1.3812	1.3747	1.3715	1.3683
30	1.1538	1.1535	1.1510	1.1456	1.1429	1.1402
35	0.9889	0.9886	0.9865	0.9819	0.9796	0.9772
40	0.8653	0.8650	0.8632	0.8591	0.8571	0.8551
45	0.7692	0.7690	0.7673	0.7637	0.7619	0.7601
50	0.6922	0.6920	0.6905	0.6873	0.6856	0.6840

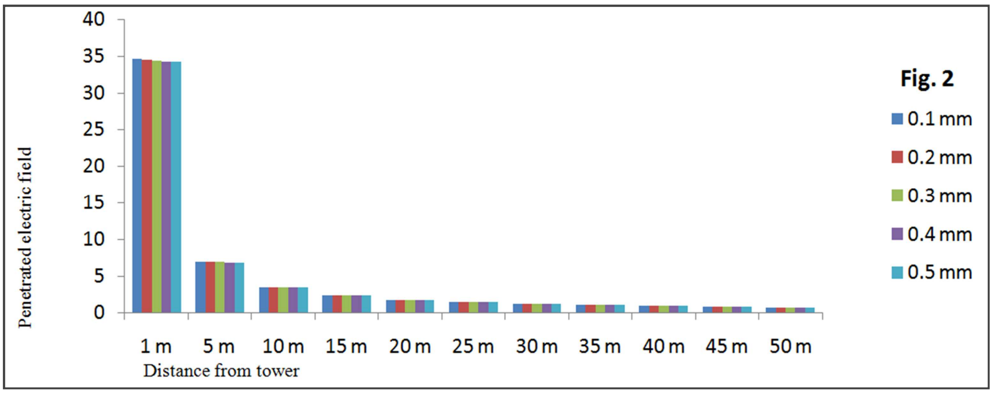

Fig. 2. *Represents a variation of penetrating electric field inside the muscles with the depth of 0.1, 0.2, 0.3, 0.4 and 0.5 mm from a mobile phone tower at frequency 900 MHz.*

Table 4. *Penetrated electric field for muscles at frequency1800 MHz.*

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.4956	34.3776	34.2601	34.1429	34.0262
5	6.9228	6.8991	6.87553	6.85202	6.8285	6.8052
10	3.4614	3.4495	3.43776	3.42601	3.4142	3.4026
15	2.3076	2.2997	2.29184	2.28400	2.27697	2.2684
20	1.7307	1.7247	1.71888	1.71300	1.7071	1.7013
25	1.3845	1.3798	1.37510	1.37040	1.3657	1.3610
30	1.1538	1.1498	1.14592	1.14200	1.1380	1.13420
35	0.9889	0.9855	0.98214	0.97879	0.97543	0.97210
40	0.8653	0.8624	0.85939	0.85645	0.85352	0.85060
45	0.7692	0.7657	0.76394	0.76136	0.7587	0.75613
50	0.6922	0.6983	0.68747	0.68512	0.6827	0.68044

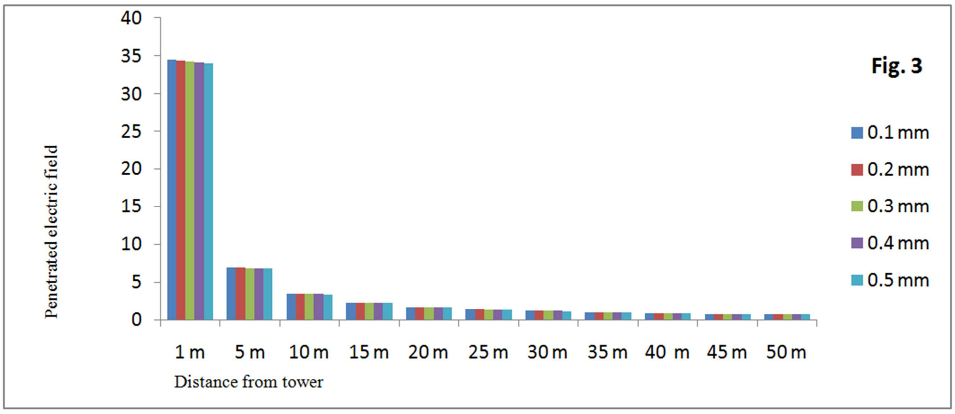

Fig. 3. *Represents a variation of penetrating electric field inside the muscles with the depth of 0.1, 0.2, 0.3, 0.4 and 0.5 mm from a mobile phone tower at frequency 1800 MHz.*

Table 5. *Penetrated electric field for muscles at frequency2450 MHz.*

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.4593	34.3053	34.1520	33.9994	33.8476
5	6.9228	6.89186	6.86107	6.83041	6.79985	6.76951
10	3.4614	3.44593	3.43053	3.41528	3.39994	3.38476
15	2.3076	2.29728	2.28702	2.27680	2.26663	2.25650
20	1.7307	1.72296	1.71526	1.70760	1.69997	1.69237
25	1.3845	1.37837	1.37221	1.36608	1.35999	1.35392
30	1.1538	1.14864	1.14351	1.13840	1.13331	1.12822
35	0.9889	0.98448	0.98008	0.97570	0.97134	0.96703
40	0.8653	0.86143	0.85758	0.85375	0.84998	0.84614
45	0.7692	0.76576	0.7623	0.75893	0.75554	0.75218
50	0.6922	0.68910	0.68602	0.68296	0.67991	0.67683

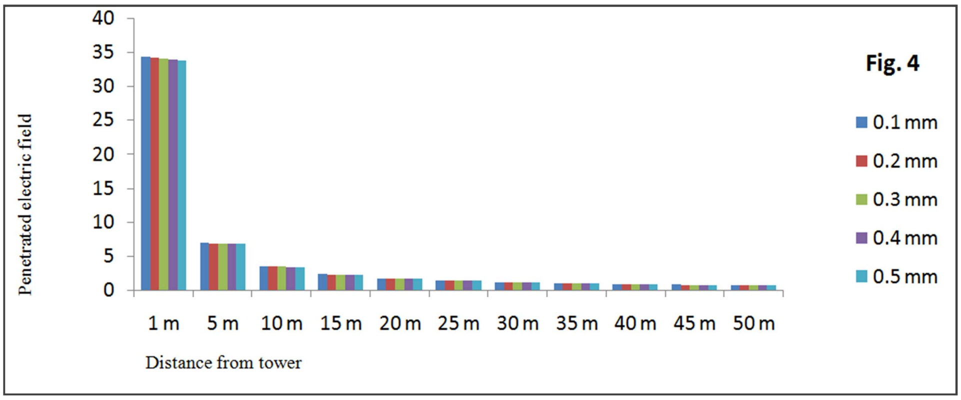

Fig. 4. *Represents a variation of penetrating electric field inside the muscles with the depth of 0.1, 0.2, 0.3, 0.4 and 0.5 mm from a mobile phone tower at frequency 2450 MHz.*

Table 6. *Penetrated electric field for bone tissue at frequency800 MHz.*

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.5899	34.565	34.541	34.5179	34.493
5	6.9228	6.91799	6.9131	6.9083	6.90351	6.8987
10	3.4614	3.45899	3.4565	3.4541	3.45179	3.4493
15	2.3076	2.30599	2.3043	2.3027	2.30119	2.2995
20	1.7307	1.72949	1.7282	1.7270	1.72585	1.7246
25	1.3845	1.38359	1.3826	1.3816	1.38071	1.3797
30	1.1538	1.15299	1.1521	1.1513	1.15059	1.1497
35	0.9889	0.98821	0.9875	0.9868	0.98615	0.9856
40	0.8653	0.86469	0.8640	0.8634	0.86289	0.8628
45	0.7692	0.76866	0.7681	0.7675	0.76705	0.7662
50	0.6922	0.69171	0.6912	0.6907	0.69027	0.6899

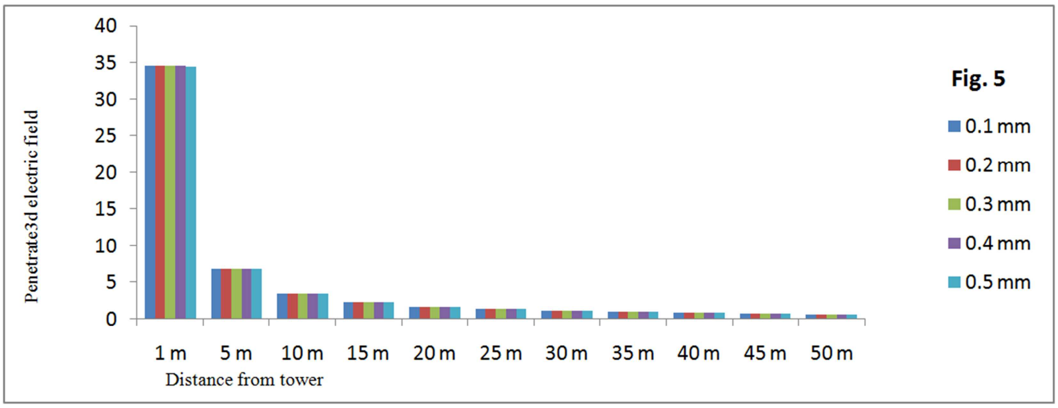

Fig. 5. *represents a variation of penetrating electric field inside the bone with the depth of 0.1, 0.2, 0.3, 0.4 and 0.5 mm from a mobile phone tower at frequency 800 MHz.*

Table 7. *Penetrated electric field for bone tissue at frequency900 MHz*

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.5877	34.561	34.535	34.593	34.482
5	6.9228	6.9175	6.9122	6.9073	6.9085	6.8941
10	3.4614	3.4587	3.4561	3.4536	3.4593	3.4481
15	2.3076	2.3058	2.3040	2.3044	2.3095	2.2987
20	1.7307	1.7293	1.7280	1.7268	1.7246	1.7245
25	1.3845	1.3835	1.3824	1.3817	1.3807	1.3793
30	1.1538	1.1529	1.1520	1.1512	1.1508	1.1494
35	0.9889	0.98	0.9873	0.9868	0.9898	0.9859
40	0.8653	0.86463	0.8639	0.8639	0.8623	0.8628
45	0.7692	0.76861	0.7680	0.7678	0.7665	0.7682
50	0.6922	0.69167	0.6911	0.6923	0.6999	0.6874

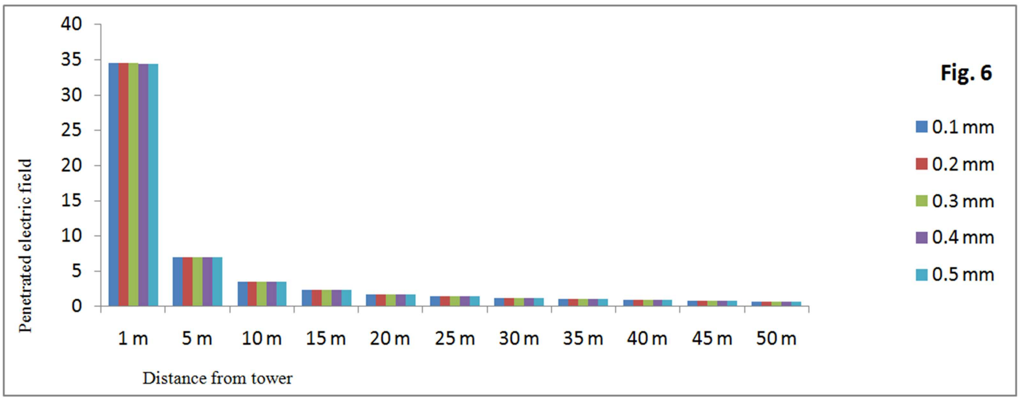

Fig. 6. *Represents a variation of penetrating electric field inside the bone with the depth of 0.1, 0.2, 0.3, 0.4 and 0.5 mm from a mobile phone tower at frequency 900 MHz.*

Table 8. *Penetrated electric field for bone tissue at frequency1800 MHz.*

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.5621	34.5102	34.458	34.408	34.355
5	6.9228	6.9124	6.9020	6.8919	6.8817	6.8710
10	3.4614	3.4562	3.4510	3.4455	3.4488	3.4355
15	2.3076	2.3041	2.3006	2.2976	2.2932	2.2903
20	1.7307	1.7281	1.7255	1.7227	1.7204	1.7177
25	1.3845	1.3824	1.3804	1.3783	1.3765	1.3742
30	1.1538	1.1520	1.1503	1.1488	1.1466	1.1451
35	0.9889	0.9874	0.9859	0.9849	0.9823	0.9815
40	0.8653	0.8640	0.8627	0.8614	0.8602	0.8583
45	0.7692	0.7680	0.7665	0.7655	0.7647	0.7634
50	0.6922	0.6911	0.6906	0.6891	0.6880	0.6877

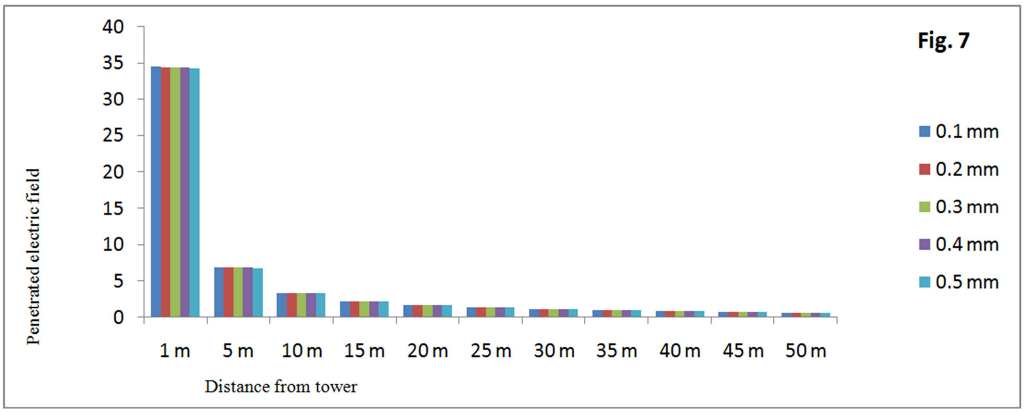

Fig. 7. *represents a variation of penetrating electric field inside the bone with the depth of 0.1 , 0.2 , 0.3 , 0.4 and 0.5 mm from a mobile phone tower at frequency 1800 MHz.*

Table 9. *Penetrated electric field for bone tissue at frequency2450 MHz.*

Distance from tower in (m)	Incident electric field around human body(E0) in (V/m)	Penetrated electric field, Ez (V/m) at depth (mm)				
		0.1	0.2	0.3	0.4	0.5
1	34.614	34.5384	34.463	34.387	34.3128	34.238
5	6.9228	6.9076	6.8926	6.8772	6.8625	6.8476
10	3.4614	3.4538	3.4463	3.4381	3.4312	3.4238
15	2.3076	2.3025	2.2975	2.2925	2.2875	2.2825
20	1.7307	1.7269	1.7231	1.7193	1.7156	1.7119
25	1.3845	1.3815	1.3785	1.3756	1.3725	1.3695
30	1.1538	1.1512	1.1487	1.1464	1.1437	1.1417
35	0.9889	0.9867	0.9845	0.9821	0.9807	0.9788
40	0.8653	0.8634	0.8615	0.8596	0.8572	0.8501
45	0.7692	0.7675	0.7658	0.7676	0.7625	0.7604
50	0.6922	0.6906	0.6891	0.6877	0.6861	0.6881

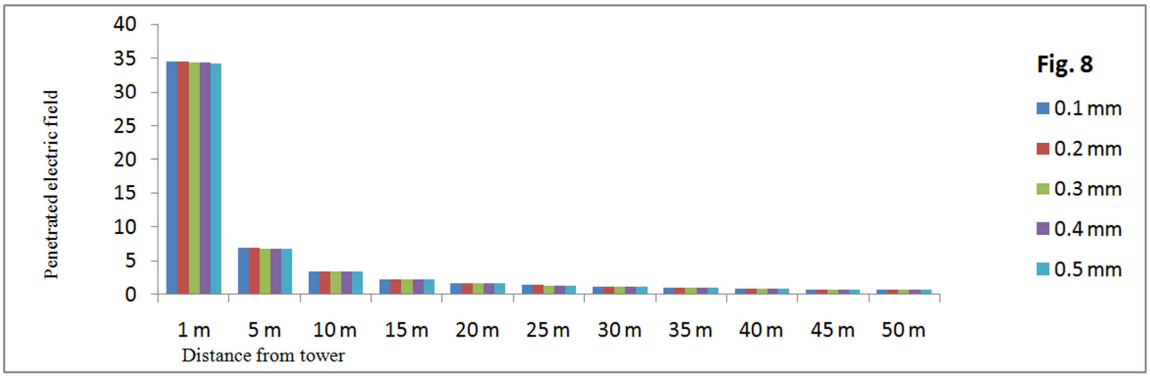

Fig. 8. *represents a variation of penetrating electric field inside the bone with the depth of 0.1 , 0.2 , 0.3 , 0.4 and 0.5 mm from a mobile phone tower at frequency 2450 MHz.*

Table 10. *SAR for muscles at frequency 800 MHz.*

Distance from tower in (m)	SAR for muscles at f=800 MHz				
	0.1 mm	0.2 mm	0.3 mm	0.4 mm	0.5 mm
1	1.0335	1.0288	1.0242	1.0195	1.0149
5	0.0413	0.0411	0.0409	0.0407	0.0405
10	0.0103	0.0102	0.0102	0.0101	0.0101
15	0.0045	0.0045	0.0045	0.0041	0.0045
20	0.0025	0.0025	0.0025	0.0025	0.0025
25	0.0016	0.0016	0.0016	0.0016	0.0016
30	0.0011	0.0011	0.0011	0.0011	0.0011
35	0.0008	0.0008	0.0008	0.0008	0.0008
40	0.0006	0.0006	0.0006	0.0006	0.0006
45	0.0005	0.0005	0.0005	0.0005	0.0005
50	0.0004	0.0004	0.0004	0.0004	0.00040

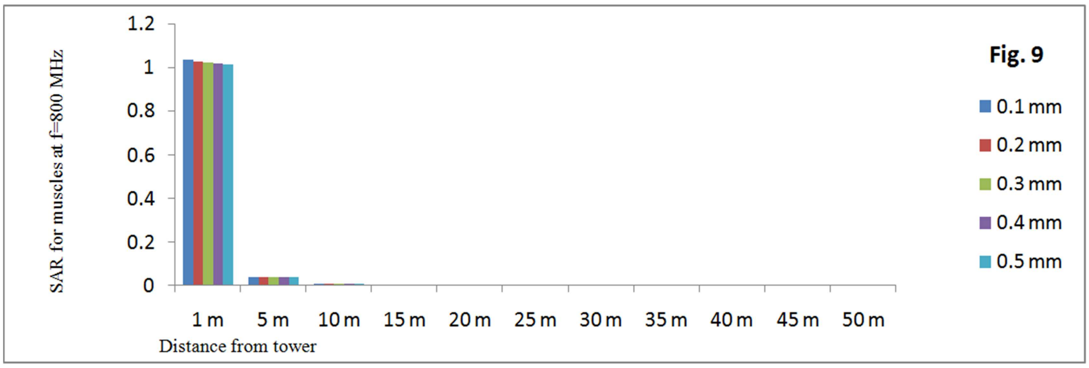

Fig. 9. *SAR in W/Kgfor muscles at frequency 800 MHz.*

Table 11. *SAR for muscles at frequency (f)= 900 MHz.*

Distance from tower in (m)	SAR for muscles at f=900 MHz				
	0.1 mm	0.2 mm	0.3 mm	0.4 mm	0.5 mm
1	1.0754	1.0708	1.0608	1.05583	1.05086
5	0.0430	0.0428	0.0424	0.04223	0.04203
10	0.0107	0.0107	0.0106	0.01055	0.01050
15	0.0047	0.0047	0.0047	0.00469	0.00467
20	0.0026	0.0026	0.0026	0.00264	0.00262
25	0.0017	0.0017	0.0016	0.00168	0.00168
30	0.0011	0.0011	0.0011	0.00117	0.00116
35	0.0008	0.0008	0.0008	0.00086	0.00085
40	0.0006	0.0006	0.0006	0.00066	0.00065
45	0.0005	0.0005	0.0005	0.00052	0.00051
50	0.0004	0.0004	0.0004	0.00042	0.00042

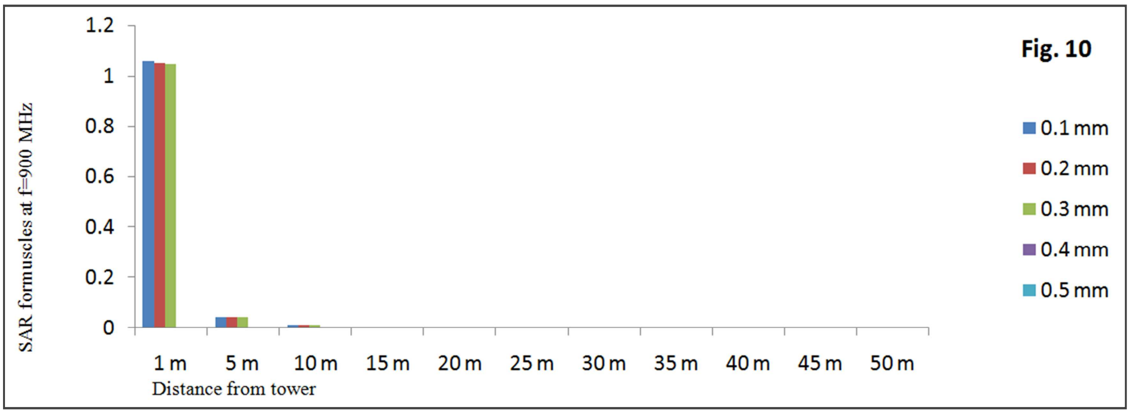

Fig. 10. *SAR in W/Kgfor muscles at frequency 900 MHz.*

Table 12. *SAR for muscles at frequency 1800 MHz.*

Distance from tower in (m)	SAR for muscles at f=1800 MHz				
	0.1 mm	0.2 mm	0.3 mm	0.4 mm	0.5 mm
1	1.51973	1.50935	1.49905	1.48881	1.47865
5	0.06078	0.06037	0.05996	0.05955	0.05914
10	0.01519	0.01509	0.01499	0.01488	0.01478
15	0.00675	0.00670	0.00666	0.00661	0.00657
20	0.00379	0.00377	0.00374	0.00372	0.00369
25	0.00243	0.00241	0.00239	0.00238	0.00236
30	0.00168	0.00167	0.00166	0.00165	0.00164
35	0.00124	0.00123	0.00122	0.00121	0.00120
40	0.00095	0.00094	0.00093	0.00093	0.00092
45	0.00075	0.00074	0.00074	0.00073	0.00073
50	0.00060	0.00060	0.00059	0.00059	0.00059

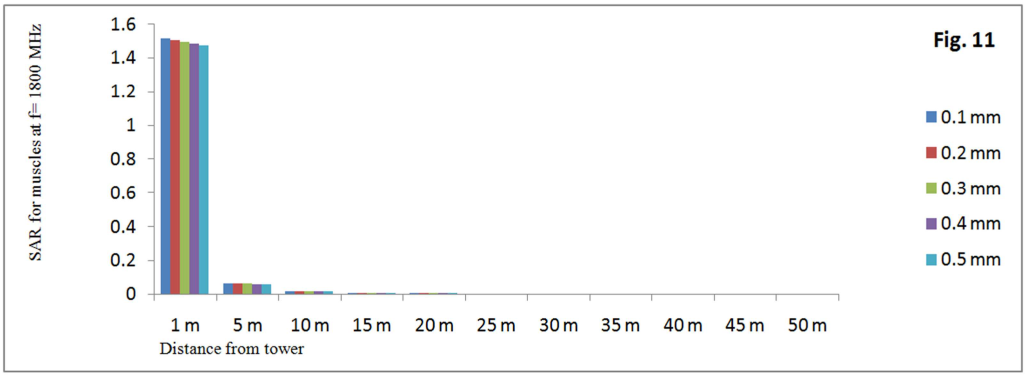

Fig. 11. *SAR in W/Kgfor muscles at frequency 1800 MHz.*

Table 13. *SAR for muscles at frequency 2450 MHz.*

Distance from tower in (m)	SAR for muscles at f=2450 MHz				
	0.1 mm	0.2 mm	0.3 mm	0.4 mm	0.5 mm
1	1.9664	1.94887	1.93149	1.91427	1.89720
5	0.07865	0.07795	0.07726	0.07657	0.07588
10	0.01966	0.01948	0.01931	0.01914	0.01897
15	0.00874	0.00866	0.00858	0.00850	0.00843
20	0.00491	0.00487	0.00482	0.00478	0.00474
25	0.00314	0.00311	0.00309	0.00306	0.00303
30	0.00218	0.00216	0.00214	0.00212	0.00210
35	0.00160	0.00159	0.00157	0.00156	0.00154
40	0.00122	0.00121	0.00120	0.00119	0.00118
45	0.00097	0.00096	0.00095	0.00094	0.00093
50	0.00078	0.00077	0.00077	0.00076	0.00075

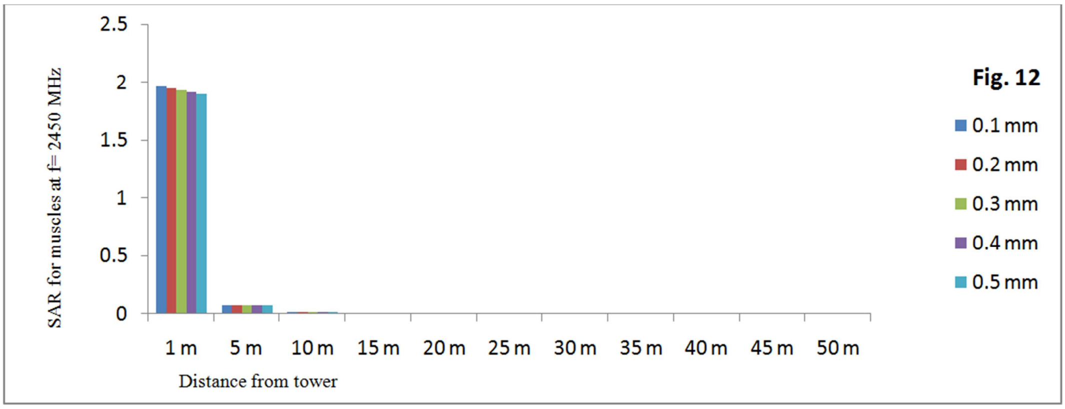

Fig. 12. *SAR in W/Kgfor muscles at frequency 2450 MHz.*

Table 14. *SAR for bone at frequency 800 MHz.*

Distance from tower in (m)	SAR for bone at f=800 MHz				
	0.1 mm	**0.2 mm**	**0.3 mm**	**0.4 mm**	**0.5 mm**
1	0.10359	0.10345	0.10330	0.10316	0.10302
5	0.00414	0.00413	0.00413	0.00412	0.00412
10	0.00103	0.00103	0.00103	0.00103	0.00103
15	0.00046	0.00046	0.00045	0.00045	0.00045
20	0.00025	0.00025	0.00025	0.00025	0.00025
25	0.00016	0.00016	0.00016	0.00016	0.00016
30	0.00011	0.00011	0.00011	0.00011	0.00011
35	8.46E-05	8.44E-05	8.43E-05	8.42E-05	8.41E-05
40	6.47E-05	6.47E-05	6.46E-05	6.45E-05	6.44E-05
45	5.12E-05	5.11E-05	5.1E-05	5.09E-05	5.09E-05
50	4.14E-05	4.14E-05	4.13E-05	4.13E-05	4.12E-05

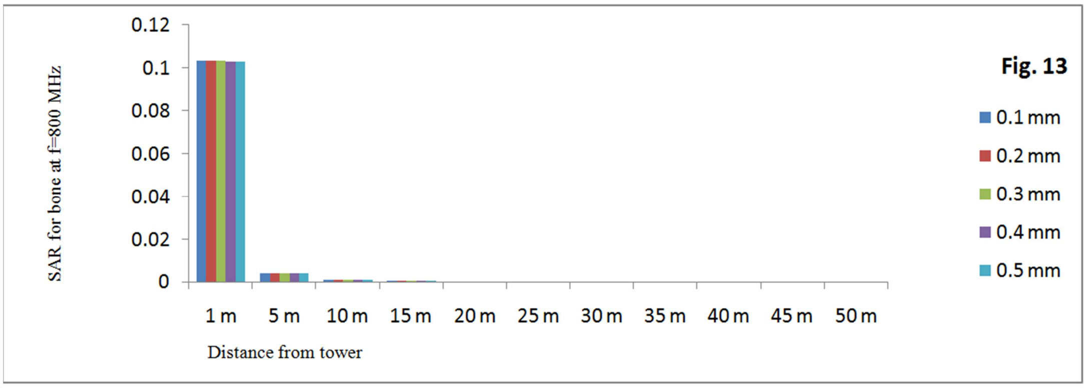

Fig. 13. *SAR in W/Kgfor bone at frequency 800 MHz.*

Table 15. *SAR for bone at frequency 900 MHz.*

Distance from tower in (m)	SAR for bone at f=900 MHz				
	0.1 mm	**0.2 mm**	**0.3 mm**	**0.4 mm**	**0.5 mm**
1	0.11279	0.11262	0.11244	0.11227	0.11210
5	0.00451	0.00450	0.00449	0.00449	0.00448
10	0.00112	0.00112	0.00112	0.00112	0.00112
15	0.00050	0.00050	0.0005	0.00049	0.00049
20	0.00028	0.00028	0.00028	0.00028	0.00028
25	0.00018	0.00018	0.00018	0.00018	0.00017
30	0.00012	0.00012	0.00012	0.00012	0.00012
35	9.21E-05	9.19E-05	9.18E-05	9.16E-05	9.15E-05
40	7.05E-05	7.04E-05	7.03E-05	7.02E-05	7.01E-05
45	5.57E-05	5.56E-05	5.55E-05	5.54E-05	5.54E-05
50	4.51E-05	4.5E-05	4.5E-05	4.49E-05	4.48E-05

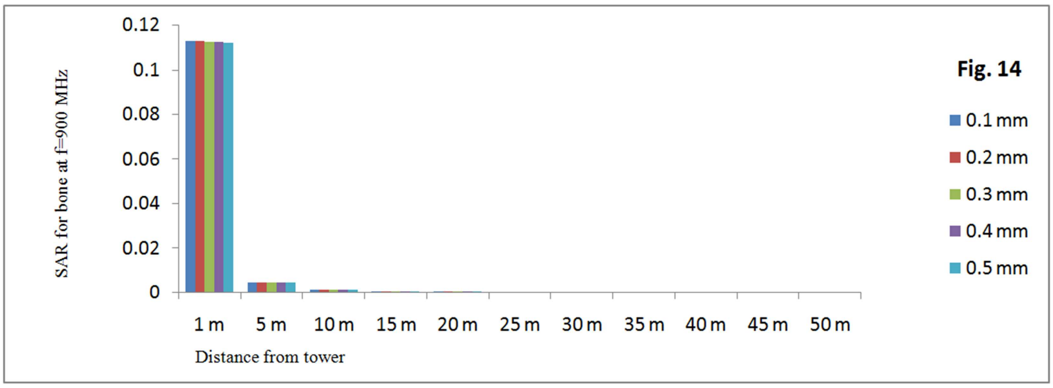

Fig. 14. *SAR in W/Kgfor bone at frequency 900 MHz.*

Table 16. *SAR for bone at frequency 1800 MHz.*

Distance from tower in (m)	SAR for bone at f=1800 MHz				
	0.1 mm	**0.2 mm**	**0.3 mm**	**0.4 mm**	**0.5 mm**
1	0.2162	0.21564	0.2149	0.21435	0.2137
5	0.0086	0.00862	0.0086	0.00857	0.0085
10	0.00216	0.00215	0.00215	0.00214	0.00213
15	0.00096	0.00095	0.00095	0.00095	0.00095
20	0.00054	0.00053	0.00053	0.00053	0.00053
25	0.00034	0.00034	0.00034	0.00034	0.00034
30	0.00024	0.00024	0.00023	0.00023	0.00023
35	0.00017	0.00017	0.00017	0.00017	0.00017
40	0.00013	0.00013	0.00013	0.00013	0.00013
45	0.00010	0.00010	0.00010	0.00010	0.00010
50	8.65E-05	8.62E-05	8.6E-05	8.57E-05	8.55E-05

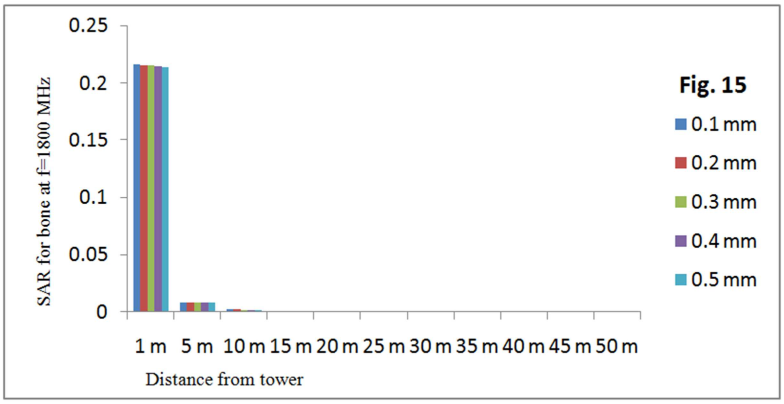

Fig. 15. *SAR in W/Kgfor bone at frequency 1800 MHz.*

Table 17. *SAR for bone at frequency 2450 MHz.*

Distance from tower in (m)	SAR for bone at f=2450 MHz				
	0.1 mm	**0.2 mm**	**0.3 mm**	**0.4 mm**	**0.5 mm**
1	0.30945	0.30810	0.30676	0.30542	0.30409
5	0.01237	0.01232	0.01227	0.01221	0.01216
10	0.00309	0.00308	0.00306	0.00305	0.00304
15	0.00137	0.00136	0.00136	0.00135	0.00135
20	0.00077	0.00077	0.00076	0.00076	0.00076
25	0.00049	0.00049	0.00049	0.00048	0.00048
30	0.00034	0.00034	0.00034	0.00033	0.00033
35	0.00025	0.00025	0.00025	0.00024	0.00024
40	0.00019	0.00019	0.00019	0.00019	0.00019
45	0.00015	0.00015	0.00015	0.00015	0.00015
50	0.00012	0.00012	0.00012	0.00012	0.00012

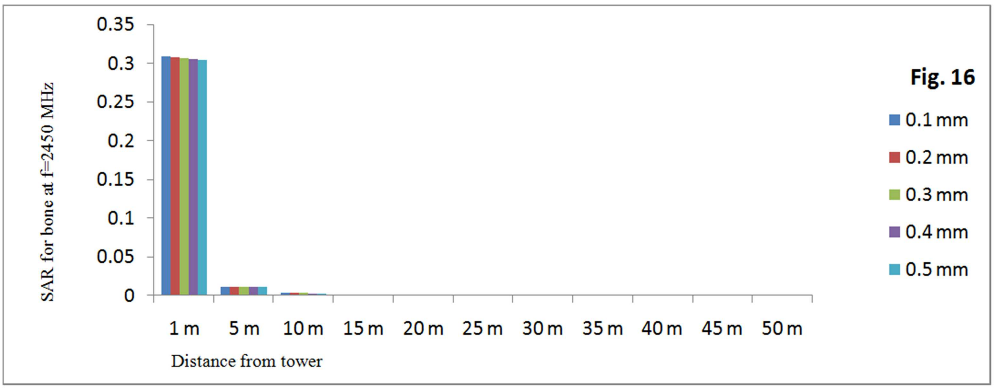

Fig. 16. *SAR in W/Kgfor bone at frequency 2450 MHz.*

4. Results and Discussion

Table 2,3, 4and 5 represent penetrating the electric field (V/m) at 0.1mm to 0.5mm depth inside the muscle tissues due to the electromagnetic wave of frequencies 800, 900, 1800 and 2450 MHz from 1 m to 50 m distance from the mobile phone tower. The calculated penetrated electric field in these tables decreases as the distance from the tower is increased. 98.00% penetrated electric field increases at different depth in the body when moves from 50 m to 1 m towards the tower.

Table 6, 7, 8 and 9 represent penetrating the electric field (V/m) at 0.1mm to 0.5 mm depth inside the bone tissues due to the electromagnetic wave of frequency 800, 900, 1800 and 2450 MHz from 1 m to 50 m distance from the mobile phone tower. The calculated electric field given in these table decreases as the distance from the tower is increased. 98.00% penetrated electric field increases at different depth in the body when move from 50 m to 1 m towards the tower.

Table 10, 11, 12 and 13 represent the specific absorption rate (SAR) for muscle tissues due to EMW of frequency 800, 900, 1800 and 2450MHz. This shows that the value of SAR decreases as the distance is increased. After comparing the data it is found that at 800, 900, 1800 and 2450 MHz frequency of mobile phone tower SAR is harmful to the life of the muscle tissues up to 1m distance from the body till 0.5 mm depth.

Table 14, 15, 16 and 17 represent the SAR for bone tissues due to EMW of frequency 800, 900, 1800 and 2450 MHz. From this it is found that at 800, 900, 1800 and 2450 MHz frequency of mobile phone tower SAR is safe for the life of the bone tissues up to 1m distance from the body till 0.5 mm depth.

5. Conclusions

As go towards the mobile phone tower from 50 meters to 1m, the penetrated electric field increase 98.00% for both muscle and bone tissues of the human body at frequencies 800, 900, 1800 and 2450 MHz. According to some International agencies as ICNIRP, WHO the specific absorption rate (SAR) becomes harmful after 1.6 W per kg. of the body weight of 75 kg. The average safe limit of SAR is 0.4 W/kg, it means that if SAR becomes greater than 120 W/kg. It may be harmful to the tissues of the human body.

It concludes from the tables 10, 11, 12 and 13, that at 800, 900, 1800 and 2450 MHz frequencies of mobile phone tower SAR is harmful to the life of the muscle tissues up to 1m from the body till 0.5 mm depth and from tables 14, 15, 16 and 17, it is also found that at 800 ,900 ,1800 and 2450 MHz frequencies of mobile phone tower SAR are safe for the life of the bone tissues up to 1m from the body till 0.5 mm depth.

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