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BIOELECTROMAGNETIC EFFECTS

By

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Abstract:

Electromagnetic radiation may be either useful or harmful to the human body according to the electromagnetic dose. For each wavelength there is a safe dose above it body will suffer from harmful symptoms such as dizziness, unstable sleeping, sever headache, inability of concentration, panic for no reason. Excessive dose may cause cancer. Egyptian law for enviroment should contain this safe electromagnetic dose limit, such as: it is safe to use mobile only 20 minutes per day, it is safe to be examined by X rays only 25 times in your life, ... etc. But it is not safe to live under high or medium tension overhead transmission lines or in front of radar or T.V or radio antenna. Keeping in mind that god had created us with no electric or magnetic fields inside us but if we are subjected to any electric or magnetic field, instantaneously a counter similar field is created.

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INTRODUCTION

Among many scientists Prof. Carl H. Derney and Douglas A. Christensen had spent 25 years in doing researches in bioelectromagntics at USA universities. They devote a long time for researching the electromagnetic energy absorbed by human body as expressed by the specific absorption rate SAR as expressed in Watts per kg. Fig 1 shows the skin depth as a function of frequency when penetrating a medium having two thirds of conductivity and permittivity of muscle tissues.

Electromagnetic radiation has many medical applications either for treatment or for diagnostic purposes. One of the treatment applications is Hyperthermia for cancer therapy where electromagnetic energy is used to heat tissues of the Body; Hyperthermia may use either capacitive applicator Fig 2 or inductive applicator Fig 3.

X rays, CT scan and magnetic resonance are examples of using electromagnetic radiation in diagnostic purposes.

In all above mentioned examples electromagnetic dose for human body is either safe or less than safe limit but to be subjected or to deal with electromagnetic or microwave bomb or electromagnetic radiation coming out of radio or T.V antennas or microwave generator or wave guides or living under high or medium tension transmission line or excessive use of mobiles, the matter is not safe, it is very complicated to explain in details the relation between each frequency band and radiated energy and specific absorbed radiation (SAR) for both muscle and fat tissues taking into consideration that polarization has a great effect on the value of relative SAR.

I do recommend that a group of youth researchers starts to make experiments on medium sized test rat to get results of SAR in watt per kg weight against frequency in MHZ. From this results SAR for human being could be deduced and then safe limits may be known.

For all personnel who are working in front of or near radar antennas I recommend them to use faraday cage.

SHORT MATHEMATICAL ANALYSES

Bioelectromagnetic researchers had agreed certain electromagnetic techniques and characteristics as a function of the relationship between system (or body) size L and electromagnetic wavelength α as follows:

1) **When wavelength α >> L**

   Electric circuit theory and quasi-static electromagnetic field theory are used. Propagation effects are negligible E and B are uncoupled. Energy is transmitted by wires or cables, but not in beams through air.

   This case means that wavelength equal 300 meter or more

2) **When Wave length α = L**

   Microwave theory is used. Propagation effect dominates. E and H strongly coupled. Energy is transmitted through cables and wave guides, and beamed through the air

   This case means that wavelength is ranging from 0.3 mm to 300 meter

3) **When α << L**

   Optics and ray theory are used. Propagation effects dominate. Energy is beamed through the air and is not transmitted through metallic cables or along metallic wires, but it can be transmitted through optical fibers This case means that wavelength is less than 0.3mm

These previous techniques states that Maxwell equations apply on an extremely broad frequency spectrum, but the characteristic between EM fields are significantly different for different frequency ranges. Specifically the characteristic depends on the size of the EM system or body compared to the wavelength.

That mathematical analysis was very useful in developing some electromagnetic diagnostic techniques based on impedance measurements or even map of the impedance of the interior of the body Fig 4 or similar techniques such as impedance imaging or microwave imaging or even MRI (magnetic resonance imaging).

IMPEDENCE IMAGING

Impedance imaging is extremely useful technique specially when we get an impedance map of the interior or the body. Such a map could provide us not only morphometric information like that provided by x-rays computed tomography (CT) scans, but it would also provide additional physiological information.

One method for mapping impedance would be to use an array of electodes around the periphery of the body as illustrated on Fig 5 and then apply voltages between pairs of electrodes, measuring currents through all electrodes each time. The cross section of the body would then be divided into mathematical cells and the data used to calculate the conductivity and / or permittivity of each of the mathematical cells by solving a set of simultaneous equations. This is similar to some reconstruction techniques used in X-rays CT method.

These reconstruction techniques work well with x-rays because the x-rays travel in straight lines through the body. These reconstruction techniques do not work well with impedance imaging, however, because the currents do not travel in straight lines between the electrodes through the body. In the human thorax, low impedance path through the chest wall shunts electrode currents around instead of the interior to provide useful images of the lungs, no matter what reconstruction techniques are used. Further more the resolution is limited by the number of electrodes used.

When impedance imaging could made useful it would be much simpler and less expensive than x-rays, magnetic resonance imaging methods.

MICROWAVE IMAGING

Some of the problems of impedance imaging could be solved by using higher frequencies. At microwave frequency, for example, and because the wavelengths are much shorter than compared with body size, the internal electromagnetic fields propagates as wave through the body, and at enough high frequencies and tends to behave as rays. These rays travel more in straight-line paths through the body, thus avoiding the problem of the chest wall shunting currents away form the interior that occurs in impedance imaging. Microwave images have been obtained by either rotating the object or by rotating the microwave applicator and receiver instead of using an array of microwave applicators and receivers.

Microwave imaging would provide different information from other kind of imaging and therefore would be a useful diagnostic tool; however, image quality will probably never approach that of the x-rays or magnetic resonance images

CONCLUSION

There is a lot of future work to be done in the field of bioelectromagnetics especially in diagnostic techniques or environmental safety regulation. This may be a good target for researchers and PH. D candidates

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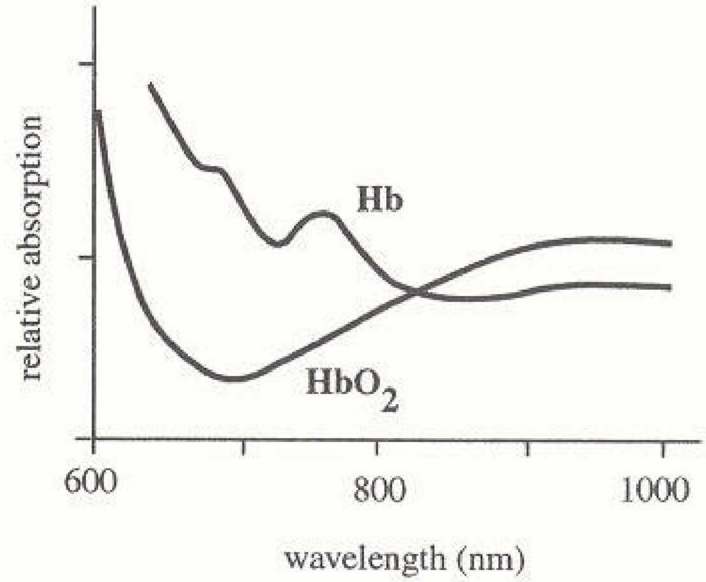
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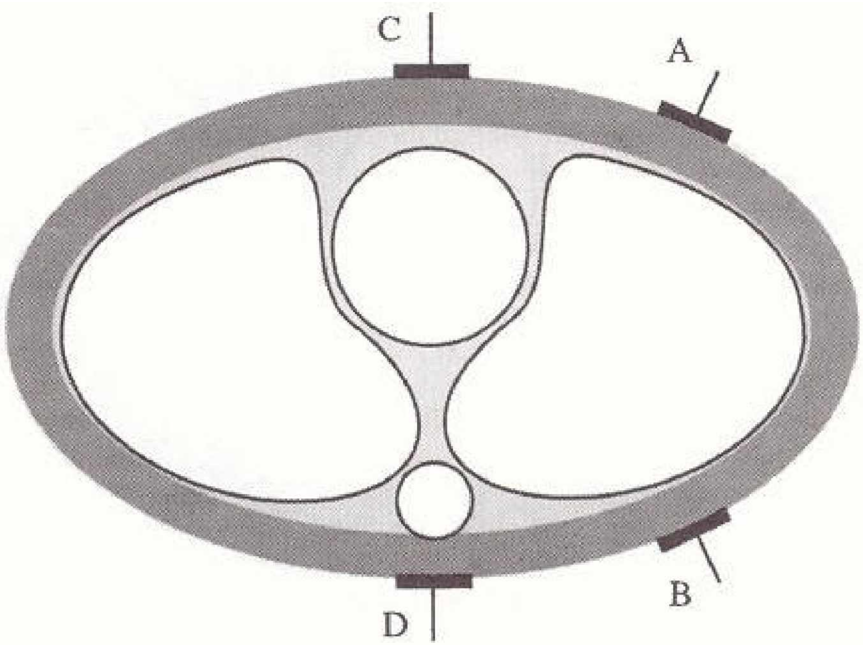
wavelength (nm)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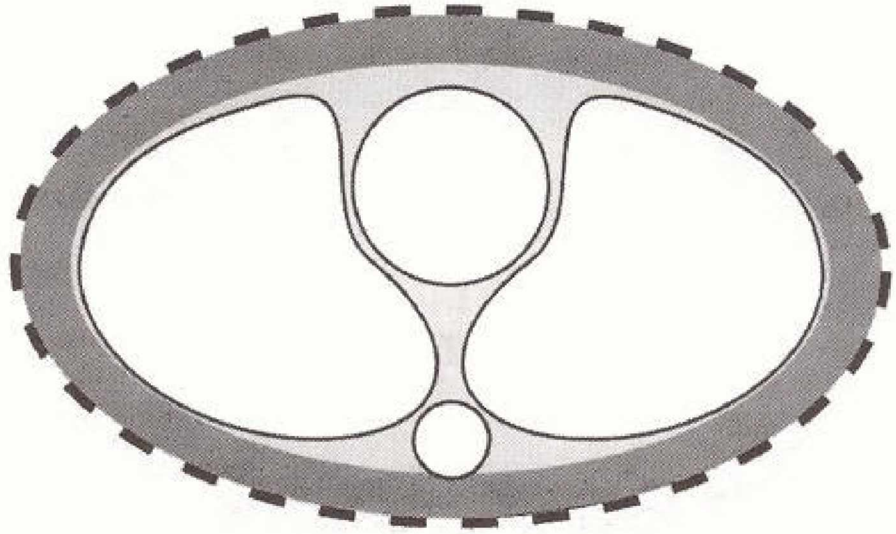

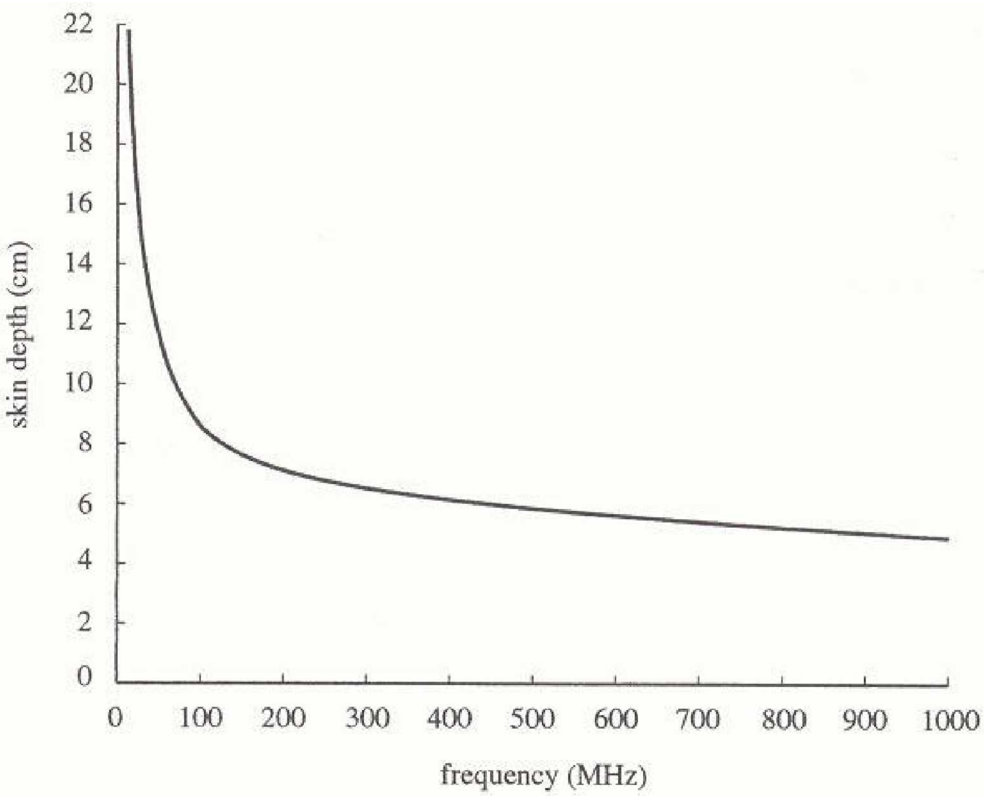
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900
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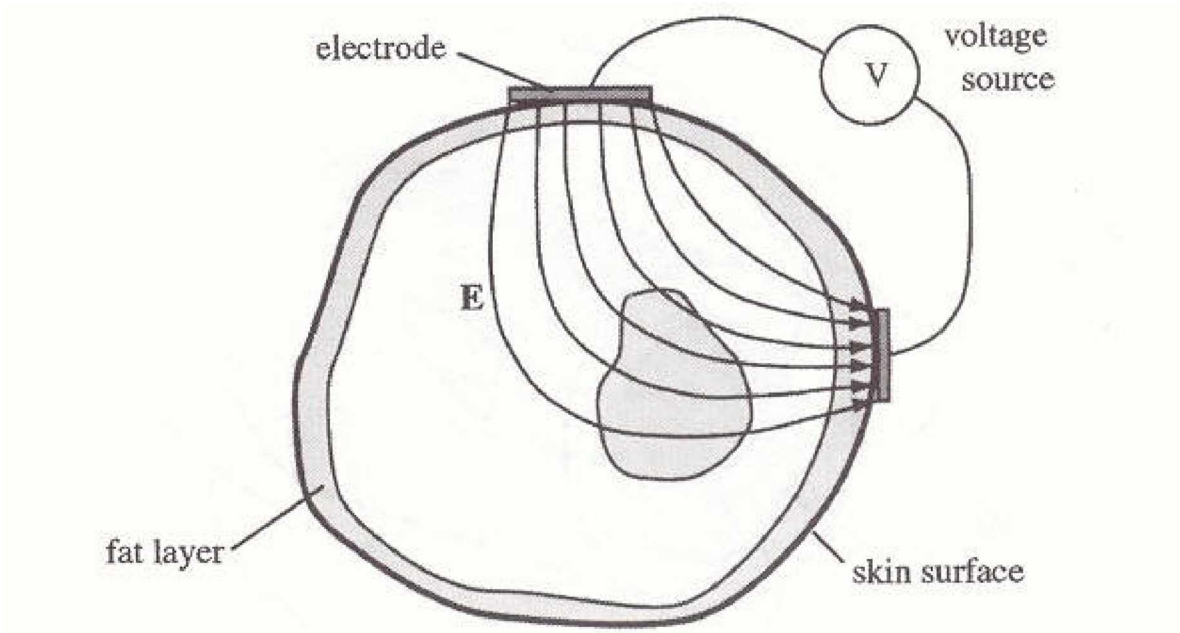
frequency (MHz)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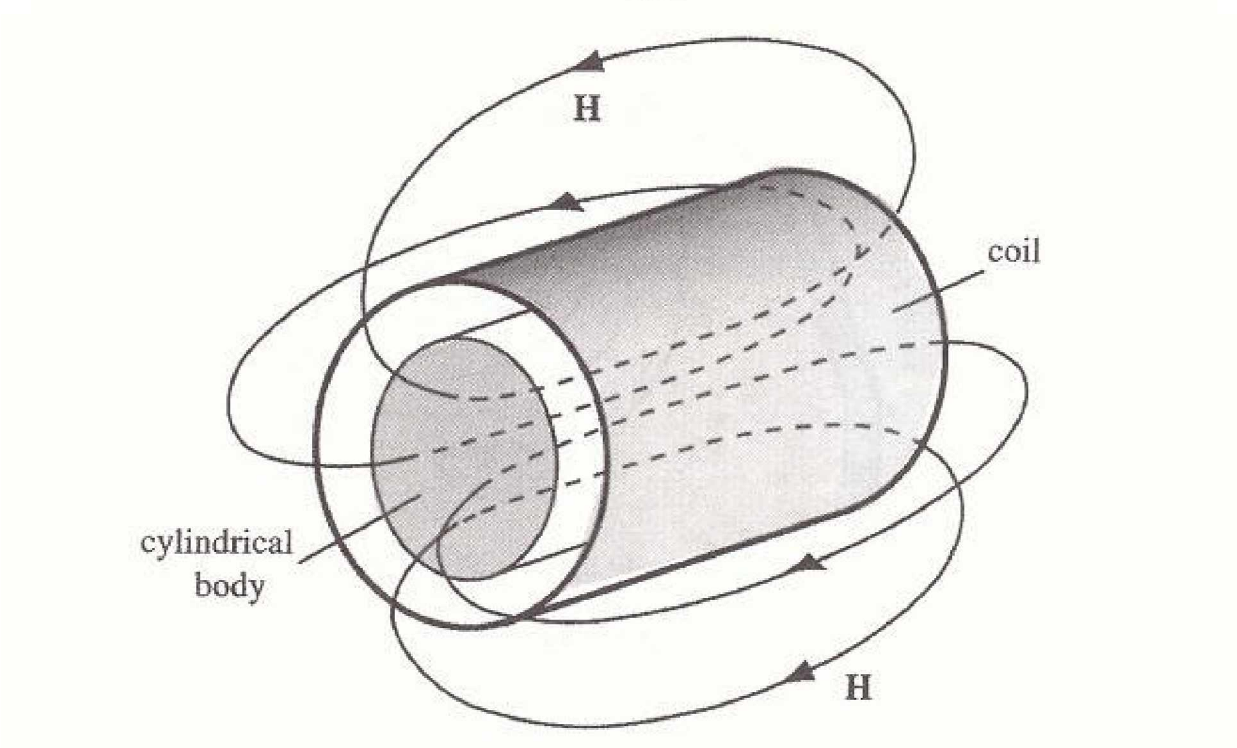
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