ADVANCED BIO MEDICAL INSTRUMENTATION

LECTURE 06: PHYSIOLOGICAL EFFECTS OF HF RADIATION

In general, the biological effects of the HF radiation have been classified as thermal and non thermal effects.

Thermal effects

It has been attributed to the dielectric heating phenomenon. The RF radiation causes a thermal heating of the biological molecules and an increase of the temperature is the noticeable effect, which lead to the following:

1. Denaturation of some molecules (as proteins) has been recognized as a result of longtime exposure with large changes in the temperature.
2. Blood flow increases to keep the body temperature constant (thermoregulation),
3. Metabolic rate increases as a result of increasing the body temperature.
4. Internal hot spots result in tissue damage (long before the overall body temperature increases) due to the penetration characteristic (about 0.1 of the radiation wavelength).
5. The tissue in the brain is sensitive to the occurrence of the hot-spots. Uncontrolled of these effects are existed during the use of mobile phone and other wireless communication devices due to there are several (shape and size of the head).
6. The thermal effect of the RF radiation to the eye makes a serious problem since the eye lens's is un- adequate for the exchange of heat. Even the increase in temperature due to the thermal effect of the RF radiation is small, it could cause protein of the lens to aggregate which may cause opacities in the lens.
7. Without increasing of the body temperature, there is effect called electrophonic effect is recognized in the microwave hearing. Where the brain tissue absorbed energy of these range of frequency that produced thermoelastic expansion and leads to acoustic pressure wave. These acoustic pressure increases the acoustic sound level (as noise pulse) that could causes annoyance, the simplest case, and the noise pulse rate affects the heart beat and metabolic rates.

Non-thermal effects

Non-thermal effects such as changes in enzyme levels. Such these effects don't have any health problems, since the body can easily compensate them. The mechanism of the effect is not clear, it could be due to normal responses of living cells to heating (thermal effect).

DEPTH OF PENETRATION

Penetration depth is a measure of how deep light or any electromagnetic radiation can penetrate into a material. It is defined as the depth at which the intensity of the radiation inside the material falls to 1/e (about 37%) of its original value at the surface.

When electromagnetic radiation is incident on the surface of a material, it may be (partly) reflected from that surface and there will be a field containing energy transmitted into the material. This electromagnetic field interacts with the atoms and electrons inside the material. Depending on the nature of the material, the electromagnetic field might travel very far into the material, or may die out very quickly. For a given material, penetration depth will generally be a function of wavelength.

SHORT WAVE DIATHERMY

Diathermy is used in physical therapy to deliver moderate heat directly to pathologic lesions in the deeper tissues of the body.

Diathermy uses an electric current to produce heat deep inside a targeted tissue. It can reach areas as deep as two inches from the skin's surface. The diathermy machine does not apply heat directly to the body. Instead, the current from the machine allows the body to generate heat from within the targeted tissue. As the heat increases, it promotes blood flow. It also can help improve flexibility in stiff joints and connective tissue.

Short wave diathermy machines utilize two condenser plates that are placed on either side of the body part to be treated. Another mode of application is by induction coils that are pliable and can be molded to fit the part of the body under treatment. As the high-frequency waves travel

through the body tissues between the condensers or the coils, they are converted into heat. The degree of heat and depth of penetration depend in part on the absorptive and resistance properties of the tissues that the waves encounter.

The frequencies assigned for short wave diathermy operations are 13.66, 27.33, and 40.98 megahertz. Most commercial machines operate at a frequency of 27.33 megahertz and a wavelength of 11 meters.

Short wave diathermy usually is prescribed for treatment of deep muscles and joints that are covered with a heavy soft-tissue mass, for example, the hip. In some instances short wave diathermy may be applied to localize deep inflammatory processes, as in pelvic inflammatory disease.