Radiology Techniques Department, College of Medical Technology, The Islamic University, Najaf, Iraq

Theoretical Radiation Physics

Third stage- Radiology Techniques Department

Lecture (11)

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The ultrasound waves divergance and interference:

The ultrasound waves divergence is the spread of waves energy as it travels away from the source, where the energy of the waves changes in the direction perpendicular to the direction of motion of the waves as well as in the direction parallel to the direction of motion of the waves.

The interference of the ultrasound waves is the superposition of ultrasound waves as a result of their spread, where in some regions there is a strengthening interference and in other regions a weakening interference, and this affects the intensity of the waves transmitted from the source to any region away from it.

Attenuation of ultrasound waves in tissues:

The attenuation of waves represents the sum of energy losses due to the processes of reflection, absorption, scattering, and refraction, and

the attenuation process depends on the nature of the medium as well as on the frequency of the ultrasound waves.

The ultrasound waves half value thickness(HVT):

The half-value thickness represents the distance within a given medium that reduces the intensity of the wave entering the medium to half of its original value, and this value depends on the nature of the medium and the frequency of the ultrasonic wave, and this can be seen from the following table

Material Or(tissue)	HVT(cm) at frequency of	
	2MHz	5MHz
muscle	0.75	0.3
blood	8.5	3
brain	2	1
liver	1.5	0.5
Soft tissue$_{av}$	2.1	0.86
water	340	54
bone	0.1	0.04
air	0.06	0.01

Acoustic windows and acoustic barriers:

Acoustic windows:

The regions which allow to the ultrasound waves to pass easily through them, for example, cavities that contain bile liquid, urine.

Acoustic barriers:

the regions or materials which impede the transmission of ultrasound waves through them, such as bone and gas.

Where bones are highly absorbent materials, and gases are highly reflective materials.

The effect of ultrasound waves frequency in attenuation process:

The attenuation process increases with the increase in the frequency of the ultrasonic waves, due to the increase in the absorption process, that is, the increase in the conversion of sound energy into thermal energy, as well as due to the increase in the dispersion of ultrasound waves as a result of the increase in the random oscillatory movement of the molecules of the medium, which leads to an increase in the acoustic impedance of the medium.

because of the rapid increase in the attenuation process due to the increase in frequency, high frequency ultrasound can not be used for

long-distance examination of tissues, hence the high frequencies reduce the ultrasound penetration.

The low penetration of high-frequency ultrasound sets the upper limits of the frequency of diagnostic ultrasound to within 15MHz.