Ultrasound:

1- Ultrasound Pictures of the Body

Bats and porpoises emit ultrasound (30 ~ 100 kHz) and listen to theechoes to navigate: delay time of echo distance to the object

- **SONAR** (Sound Navigation and Ranging) it was discovered duringWorld War II,
- where the sound wave pulse is sent out and reflected from object.
-From the time required to receive the echo and the known velocity ofsound in water, the distance to the object can be determined.

To obtain diagnostic information about the depth of structures in the body, we send pulses of ultrasound into the body and measure the time required toreceive the reflected sound (echoes) from various surfaces in it. This procedure is called the A scan method of ultrasound diagnosis.

1- A scan

- Pulse transmission: a few s long pulse with 400 ~ 1000 pulse/s.

-Two medium with different acoustic impedance reflection.

Application of A scans procedure :

-echoencephalography has been used in the detection of brain tumors. Pulses of ultrasound are sent into a thin region of the skull slightly above the ear and echoes from the different structures within the head are displayed on oscilloscope, the usual procedure is to compare the echoes from the left side of the head to those from the right side and tolook for a shift in the midline structure. A tumor on one side of the brain tends to shift the midline toward the other side, a shift of more than 3mm for adult or 2mm for child is considered abnormal.

- ophthalmology can be divided into two areas:

One is concerned with obtaining information for use in the diagnosis ofeye diseases.

Second involves biometry, or measurements of distances in the eye.At the low power levels used, there is no danger to the patient's eye.

Ultrasound frequencies of up to 20MHz are used, These high frequenciescan be used in the eye to produce better resolution since there is no bone

to absorb most of the energy and absorption is not significant because theeye is small.
-Ultrasound diagnostic techniques provide information about the deeper regions of the eye and are especially useful when the cornea or lens is opaque. Tumors, foreign bodies, and detachment of the retina (the light-sensitive part of the eye) are some of the problems that can be diagnosedwith ultrasound.
With ultrasound, it is possible to measure distances in the eye such as lensthickness, depth from cornea to lens, the distance to the retina, and the thickness of the vitreous humor.

- B scan

For many clinical purposes A scans have been replaced by B scans. The B scan method is used to obtain two-dimensional views of parts ofthe body .The principles are the same as for the A scan **except** that the transducer is moved. As a result, each echo produces a dot on the oscilloscope at a position corresponding to the location of the reflecting surface. A storage oscilloscope is usually used so that a lasting image canbe formed and a photograph can be made.
B scan provide information about the internal structure of the body. Theyhave been used in diagnostic studies of

the eye, liver ,breast, heart, and fetus. They can detect pregnancy as early as the fifth week and can provide information about uterine anomalies.

2-Ultrasound to Measure Motion:

Two methods are used to obtain information about motion in the body with ultrasound:

1- M (motion) scan.

Used to study motion of the heart and heart valves.

The M scan combines certain features of the A scan and B scan. The transducer is held stationary as in the A scan and the echoes appear as dots as in the B scan of the mitral valves and pericardial effusion can be detected with an M scan.

2- Doppler technique

-Used to measure blood flow.

-Detect motion of fetal heart, umbilical cord, and placenta in order to establish fetal life during the 12 to 20 week of gestation.

Physiological Effects of Ultrasound in Therapy

Low intensity ultrasound levels used for diagnostic work (0.01 W/cm^2 average power and $20W/cm^2$ peak power) **no harmful effects**
are observed.
As the power is increased, ultrasound becomes **useful** in therapy. Ultrasound is used as a deep heating agent at continuous intensity levels of about 1 W/cm^2 and as a tissue-destroying agent at intensity levels of 10^3 W/cm^2.
The primary physical effects produced by ultrasound are temperature increase and pressure variation. The primary effect used for therapy is the temperature rise due to the absorption of acoustic energy in the tissue.
Ultrasound diathermy complements deep heating electromagnetic diathermy.
Ultrasound waves differ completely from electromagnetic waves, they interact with tissue primarily by microscopic motion of the tissue particles. As a sound wave moves through tissue, the regions of compression and rarefaction cause pressure differences in adjacent regions of tissue. Stretching occurs in these regions, if the stretching exceeds the elastic limit of the tissue, tearing results.
This is why an eardrum can be ruptured by a very intense sound source.

In physical therapy the typical intensity is about 1 to

10 w/cm^2 and the frequency is about 1 MHz .

The maximum pressure amplitude Po = 5 atm.

-Intense ultrasound waves can change water into H_2 and H_2O_2 and rupture DNA molecules.

***Negative pressure in the tissue during rarefaction can cause dissolved gas to come out of solution and form bubbles. This forming of bubbles called cavitation.

At power levels of 10^3 w/cm^2 it is possible to selectively destroy tissue at a desired depth by using a focused ultrasound beam .