Transvaginal Ultrasonography

Introduction:

The use of transvaginal ultrasonography was suggested in 1966 ***(Mizuno et al., 1966)*** but not seriously considered until 1969 ***(Kratochwil, 1969).***

The first use of high frequency TVS was reported on 1988 by **(Timor - *Tritsch et al. 1988)*** and pulsed doppler was added on 1988 ***(Deutinger et al., 1988).*** More recently, color flow mapping was developed in 1989 ***(Kurjak, 1989)***.

Physics of transvaginal Ultrasonography

A pulse of high-frequency sound is launched into the body using a piezoelectric transducer. The pulse sound travels along a thin beam and echoes are reflected from any tissue interface ***(Zagzebski, 1994)***.

A. Interference

The formation of beams is dependent on interference between sound pressure waves. An ultrasound wave, like audible sound, comprises a succession of high- and low-pressure regions that travel through the tissue at the speed of sound which is about 1500m/s in the body ***(Zagzebski, 1994)***.

The distance between successive high pressure regions is termed the wave length. If the high pressure region from one wave coincides with the low-pressure region from another, the net result is that the pressure will remain unchanged (destructive interference). If the high pressure regions from the two waves coincide, the sound pressure where they cross will be proportionately increased (constructive interference) ***(Starczewski et al., 2005)***.

B. Frequency and frequency spectrum

The number of pressure peaks generated in one second is termed the frequency of the wave. Determination of the frequency of the pulse at all other similar points on the wave give rise to a spectrum of frequencies ***(Zagzebski, 1994)***.

C. Intensity

Work is required for the sound pulse to move molecules in the body. The rate at which work is done is termed power. The power measured over a small area, is called the intensity of the beam at that point and is expressed in watts per square meter ***(Fleischer et al., 2001).***

D. Attenuation, scatter and absorption

Attenuation is the loss of intensity of a pulse as it travels through the tissues. It occurs as the beam diverges by absorption and as the pulse is reflected from each tissue structure. **Reflection** from small structures is called scattering. **Absorption** is a significant factor in attenuation that is caused by viscous friction and relaxation processes ***(Zagzebski, 1994)***.

E. Reflection

Each time, an interface between different tissues is encountered by a pulse passing through the tissues. A small proportion of the energy is reflected as an echo. The proportion of sound energy reflected at a boundary depends on the difference in the characteristic impedance of the tissue forming the interface ***(Starczewski et al., 2005).***

F. Resolution

Spatial resolution is the ability of the image to portray small anatomic details. Usually the limiting separation is smaller along the beam in the axial direction than across the beam in the lateral direction. Thus the axial direction is better than the lateral direction. The resolution will vary at different points on the image and will be better in the focal regions than elsewhere ***(Fleischer et al., 2001).***

Theoretically, it is not possible to achieve a resolution of better than one wavelength or 0.5 mm at 3 MHz. The shortest pulses found in practice are at least one and a half wavelength long so the best achievable axial resolution is about 0.75 mm at 3 MHz ***(Zagzebski, 1994)****.)*

Improvement of the image by the machine can be done by digital image storage, focusing, synthetic aperture techniques, dynamic range and smoothing ***(Starczewski et al., 2005****).*

Technique and instrumentation:

Most of available machines use 5 - 7.5 MHz probe which can give a depth of penetration of about eight cm with focal range of 2-6 cm.

The image display angle is typically 90- 100 degree but can be as wide as 270 degree. Most of transvaginal scanners contain single element oscillating transducer, however various array transducer are available especially in duplex machines ***(Fleischer et al., 2001).***

For TVS, an empty bladder is preferred. Overfilling of the bladder will cause cephalad displacement or retroflexion of the uterus, pushing it out of the image plane. The woman lie supine with flexed legs and the probe is introduced into the vagina covered with a condom containing transducer gel. The condom is then covered with sterile gel before introduction. Routine examination should include the uterus, Fallopian tubes, ovaries and cul-de sac. Examination of other pelvic organs is done only when needed ***(Fleischer et al., 2001).***

The vagina and uterus provide anatomic landmarks that can be used as reference points for the other pelvic structures, whether normal or abnormal.

In examining the uterus, the following should be evaluated:

a) The uterine size, shape, and orientation
b) The endometrium
c) The myometrium
d) The cervix.

The vagina may be imaged as a landmark for the cervix and lower uterine segment ***(Mary C. Frates, et al. 2009)***

Overall uterine length is evaluated in long axis from the fundus to the cervix (to the external os, if it can be identified). The depth of the uterus (anteroposterior dimension) is measured in the same long-axis view from its anterior to posterior walls, perpendicular to the length.

The maximum width is measured in the transaxial or coronal view. If volume measurements of the uterine corpus are performed, the cervical component should be excluded from the uterine length measurement **(Mary C. Frates, et al. 2009)**

The endometrium should be analyzed for thickness, focal abnormality, and the presence of fluid or masses in the endometrial cavity.

The endometrium should be measured on a midline sagittal image, including anterior and posterior portions of the basal endometrium and excluding the adjacent hypoechoic myometrium or any endometrial fluid. If the endometrium is difficult to image in its entirety, or ill-defined, it should be reported. Sonohysterography may be a useful adjunct to evaluate the patient with abnormal or dysfunctional uterine bleeding or to further clarify an abnormally thickened endometrium. If the patient has an intrauterine contraceptive device, its location should be documented ***(Starczewski et al., 2005)***.

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