The Current concepts in the role of Two-dimensional, Three-dimensional and color Doppler Ultrasonography in the diagnosis and evaluation of gynaecological malignancies

Essay

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Abstract

Gynecologic malignancy is a leading cause of cancer in women and constitutes a significant health issue worldwide. Many efforts have been carried out to improve the accuracy of sonography in discriminating benign from malignant lesions.

Pelvic ultrasonography is considered an appealing alternative to laparoscopy in diagnosing gynecological malignancies.

The introduction of transvaginal color Doppler ultrasonography into gynecological use can better demonstrate the vascular features of gynecological pathology.

Also the introduction of contrast enhanced three-dimesional power Doppler imaging, that easily and precisely discriminate benign from malignant gynecological lesions, is considered the most recent evolution in imaging techniques.

Recently, the application of 3D/US represents a noval approach for early and accurate detection of gynecological cancer.

Keywords:

Gynecological malignancies, two-dimensional ultrasound, three-dimensional ultrasound, color Doppler, transabdominal ultrasound, transvaginal ultrasound, three-dimensional power Doppler.

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Ob/Gyn.	Obstetrics and Gynecology
2D US	Two-dimensional Ultrasound
3D US	Three-dimensional Ultrasound
TVU, TVUS	Transvaginal ultrasound
TVS	Transvaginal sonography
RI	Resistive index
US	Ultrasound
DCIS	Ductal carcinoma in situ
ACR-BIRADS	American college of radiology-breast imaging reporting & data system
4D US	Four-dimensional Ultrasound
MHz	Mega-hertz
MRI	Magnetic resonance imaging
CAD	Computer aided detection
PET	Positron emission tomography
HRT/HT	Hormonal replacement therapy
ET	Endometrial thickness
B-mode	Brightness mode
PI	Pulsatility index
BRCA-1	Breast cancer gene-1
BRCA-2	Breast cancer gene-2
CI	Confidence interval
EOC	Epithelial ovarian cancer
CT	Computed tomography
SLN	Sentinel lymph node
EORTC	European organization for research and treatment of cancer
RT-PCR	Reverse transcriptase-polymerase chain reaction
VAIN	Vaginal intraepithelial neoplasia
HPV	Human papilloma virus
DES	Diethylstilbestrol
FDG	Fluoro-Dioxyglucose
VS	Versus
USG	Ultrasonography
IVD	Intra-Vascular Doppler

INTRODUCTION

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A long time ago, at a seminar in the early 1980s, someone asked a popular obstetrician and professor at Georgetown University, "What are the three most significant technological advances in ob/gyn in the last 30 years?" The answer came quickly from Dr. John T. Queenan: "Ultrasound, ultrasound, and ultrasound." By then-and since then even more-this diagnostic modality has transformed the practice of obstetrics & gynaecology, not to mention its effect on other specialties.(**Jacques S.Abramowikz, 1980**)

Ultrasound imaging, also known as ultrasound scanning or sonography is a method of obtaining images from inside the human body through the use of high-frequency sound waves. The echoes of the sound waves are recorded and displayed as a real-time, visual image. Computer calculation of the distance to the sound-reflecting or absorbing surface plus the known orientation of the sound beam gives a two- or three-dimensional image. Non ionizing radiation is involved in ultrasound imaging.(**American Cancer Society, Ov.Cancer, 2007)**

Two-dimensional transvaginal ultrasound (2D US) is widely used in gynecological practice and its reliable diagnostic value is well established. Although an experienced examiner may develop a three-dimensional image in her or his mind by a “mental processing” of a sequence of 2D images, the ability to obtain certain planes of the pelvic organs is limited.(**Juan Luis Alcazar, 2005)**

Three-dimensional ultrasound (3D US) has been introduced into clinical practice during the last fifteen years. With this technology, any desired plane through an organ can be obtained. With 3D US, a volume of a region of interest can be acquired and stored. This volume can be further analyzed in several ways, such as navigation, multiplanar display, surface rendering or volume calculation. Although, this technique has been more extensively used in Obstetrics, clinical applications in Gynecology have been and are currently being explored, with a steady

increase in the number of papers published in the last five years.(**Juan Luis Alcazar, 2005)**

Gynecologic malignancy is a leading cause of cancer in women and constitutes a significant health issue worldwide. It accounts for approximately 20% of visceral cancers. In 2003, 83,700 gynecologic malignancies were newly diagnosed and 26,800 patients died . Although uterine cancer has the highest incidence of all gynecologic malignancies, ovarian cancer has the highest mortality.(**Neeta Pandit-Taskar,2005)**

A transvaginal ultrasound (TVU, TVUS), also known as transvaginal sonography (TVS), involves the insertion of the transducer into the vagina. The images are obtained from different orientations to get the best views of the uterus and ovaries. Doppler sonography can also be performed through the transvaginal transducer.(**American Cancer Society, Ov.cancer, 2007)**

Two dimensional transabdominal and transvaginal ultrasonography are also accepted tools in clinical decision making but their validity is also restricted because of their limited sensitivity and specifity. High diastolic flow or low resistance is a pathognomonic feature of vasculature with neoplasms. Neovascular vessels lack of vascular intima form multiple arteriovenous shunts resulting in an increased diastolic flow detectable in the doppler frequency wave form. More recently, several investigators have been able to distinguish benign from malignant lesions by using color doppler flow mapping and pulsed doppler.(**Tayfun Gungor, 1997)**

However neovascularity is not specific to malignancy it may also be seen in benign tumors with high proliferative or inflammatory potential. Morphologic assessment of ovarian masses with transvaginal and transabdominal sonography is also used for the detection of malignant tumors however the predictive values are unsatisfactory because of frequent inability to distinguish between malignant and benign tumors with similar morphologic characteristics.(**Tayfun Gungor, 1997)**

The aim of this study is to evaluate the effectiveness of 2D, 3D and color doppler sonography in the diagnosis of ovarian, uterine and other genital tract malignancy and to find out an optimal cut off value for RI.(**Tayfun Gungor, 1997)**

`In this review, I shall address current applications of 2D, 3D, and doppler US in Gynecological malignancies, including a brief description of some technical aspects, as well as to explore some future perspectives.

CHAPTER I

Physics Of Ultrasound

Physics of Ultrasound

Basic principles

- Imaging principles of Two-dimensional ultrasound:

In medical imaging, high frequency sound, or ultrasound, is generated by a transducer that rests on the tissues that convert electrical energy into mechanical (acoustic) energy. This energy travels as pulses rapidly through the body, and reflections occur at interfaces between tissues with different acoustic characteristics, these reflections (or echoes) return to the transducer, which is (listening) for them and convert them back to electrical energy (**Johan, 1999).**

2D-Ultrasound technique:

A systemic study of the pelvis is carried out in both sagittal and transverse planes. The sagittal scans begin in the midline and proceed to the pelvic sidewalls. To include the visualization of the iliopsoas muscle group and/or the bony pelvis. The margin of the bony pelvis is identified as a highly reflective line with no thorough transmission of sound. The variable positions of the ovaries makes a complete survey of the pelvis is necessary, as they may lie anywhere from immediately posterior to the uterus in the Douglas pouch to laterally against the pelvic sidewall. The transverse scans should proceed from the level of the vagina to above the uterine fundus to insure complete convergence. It's often useful to place the transducer in a Para median position and navigate through the filled bladder to image the contra lateral adnexa (**Keith, et al., 2001).**

3D-Ultrasound technique:

- Data acquisition technique:

Three-dimensional images can be constructed with 2D US arrays, which produce 3D image data directly. More commonly, they are reconstructed from a series of 2D images produced with one-dimensional US arrays. Regardless of which method is used, one must know the

relative position and angulation of each 2D image and must acquire the images rapidly or with gating to avoid motion artifacts. If these two criteria are not met, the 3D images may be inaccurate. (**Donal B.Downey, 1999).**

The four main types of 3D US data acquisition systems are (*a*) tracked freehand systems, (*b*) untracked freehand systems, (*c*) mechanical assemblies, and (*d*) 2D arrays.(**Aaron Fenster, 1999).**

- Tracked Freehand Systems***:***

With tracked freehand systems, the operator holds an assembly composed of the transducer with an attachment and manipulates it over the anatomic area being evaluated (Fig 1). Two-dimensional images are digitized as the transducer is moved. During this procedure, the exact relative position and angulation of the US transducer must be known for each digitized image, and the operator must ensure that there are no significant imaging gaps.(**Donal B. et al., 1999)**

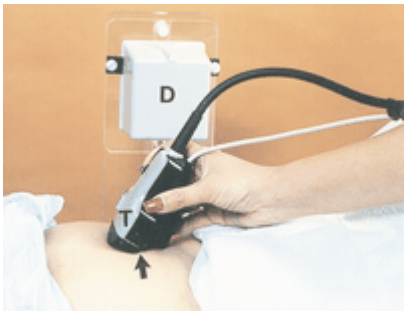

Figure 1. Tracked freehand 3D scanning. (**Donal B.et al., 1999)**

- Untracked freehand systems :

With untracked freehand systems, 2D images are digitized as the operator moves the transducer with a smooth, steady motion (Fig 2). Although this technique is usually the most convenient for the operator, image quality is variable and depends largely on how smoothly and steadily the operator moves the transducer. To reconstruct a 3D image, a linear or angular space between digitized images is assumed. Geometric measurements such as distance or volume may be inaccurate and should not be taken because there is no direct information regarding the relative position of the digitized images. (Fig.2). (**Aaron Fenster et al., 1999)**