Role of 3D-Ultrasonography in the evaluation of postmenopausal bleeding

Thesis

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Abstract

Transvaginal ultrasound is often recommended as a preliminary 'noninvasive' technique for assessing the endometrium in women with PMB.

Unfortunately, it cannot give a definitive answer as to the presence or absence of malignancy, although it can sometimes be helpful in the assessment of uterine polyps.

There is no consensus in the literature as to what the cut-off value for normal endometrial thickness should be. It has been reported as anywhere from 4–8 mm.

Obviously the lower the cut-off value, the higher the sensitivity for detection of endometrial cancers and its precursors but at a cost of lower specificity and increased false positives.

Keywords:

Three-dimensional transvaginal ultrasound, color Doppler, transabdominal ultrasound,.endometrial thickness, atrophic endometrium, endometrial hyperplasia, endometrial malignancy, polyp, myoma, endometritis.

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Ob/Gyn.	Obstetrics and Gynecology
2D US	Two-dimensional Ultrasound
3DHS	Three-dimensional hysterosonography
3D-HyCoSy	Three-dimensional hysterosalpingo contrast sonography
3DPD	Three-dimensional power doppler
3D US	Three-dimensional Ultrasound
4D US	Four-dimensional Ultrasound
ACR-BIRADS	American college of radiology-breast imaging reporting & data system
AFP	Alpha fetoprotein
ANOVA	Analysis of variance
B-mode	Brightness mode
BMI	Body mass index
BRCA-1	Breast cancer gene-1
BRCA-2	Breast cancer gene-2
CA	Cancer Antigen
CAD	Computer aided detection
CDC	Center for disease control
CI	Confidence interval
CT	Computed tomography
D	Diastolic
D & C	Dilatation & curettage
DCIS	Ductal carcinoma in situ
DES	Diethylstilbestrol
DGC	Depth gain compensation
E2	Estradiol
EOC	Epithelial ovarian cancer
EORTC	European organization for research and treatment of cancer
EP	Extrauterine pregnancy
ET	Endometrial thickness

FDG	Fluoro-Dioxyglucose
FI	Flow index
FMP	Final menstrual period
FSH	Follicular Stimulating hormone
GI	Gastro-intestinal
hCG	Human chorionic gonadotropins
HNPCC	Hereditary non-polyposis colorectal cancer
HRT/HT	Hormonal replacement therapy
HSG	Hysterosalpingography
HSSG	Hystero-sono-salpingography
HPV	Human papilloma virus
IVD	Intra-Vascular Doppler
KHz	Kilo-hertz
LH	Luteinizing Hormone
MD	Medical doctor
MHz	Mega-hertz
MI	Myometrial invasion
MRI	Magnetic resonance imaging
MWMHP	Melbourne Women’s Midlife Health Project
NPV	Negative predictive value
P	probability
PDU	Power doppler ultrasound
PET	Positron emission tomography
PI	Pulsatility index
PID	Pelvic inflammatory disease
PMB	Postmenopausal bleeding
PPV	Positive predictive value
r	Pearson correlation
RI	Resistive index
ROC	Receiver operating curve
RRs	Relative risks
RT-PCR	Reverse transcriptase-polymerase chain reaction
RVF	Retro-verted flexed
S	Systolic
SCSH	Saline contrast sonohysterography
SIS	Saline-infusion sonography
SLN	Sentinel lymph node
SMWHS	Seattle Midlife Women’s Health Study
SONAR	Sound navigation and ranging
STRAW	Stages of Reproductive Aging Workshop
TAS	Transabdominal sonography
TGC	Time gain compensation
TOA	Tubo-ovarian abscess
TVCDS	Transvaginal color doppler sonography
TVU, TVUS	Transvaginal ultrasound
TVS	Transvaginal sonography
US	Ultrasound
USG	Ultrasonography

VAIN	Vaginal intraepithelial neoplasia
VFI	Vascularization flow index
VI	Vascularity index
VOCAL	Virtual organ computer-aided analysis
VS	Versus
WHO	World Health Organization

INTRODUCTION

Introduction

With advances occurring in medicine on a daily basis, it was only a matter of time before essential gynecological investigations, such as ultrasound, were modified. Many clinicians remain unconvinced by its reputed advantages and 3D ultrasound is not without disadvantages. (**Albufalia et al., 2001)**

These mainly relate to the cost implications and training requirements. 3D ultrasound imaging is still at a relatively early stage in terms of its role as a day-to-day imaging modality in gynecology and reproductive medicine. (**Alcazar et al., 2004)**

3D imaging has several obvious benefits that relate to an improved spatial orientation and the demonstration of multiplanar views, of which the coronal plane is particularly useful. It offers a more objective and reproducible measurement of volume and vascularity of the region of interest, and an improved assessment of normal and pathological pelvic organs through further postprocessing modalities, including tomographic ultrasound imaging and various rendering modalities. It also has the benefit of offering reduced scanning time, the option of teleconsultation and storage of images for re-evaluation. (**Baba K. et al., 1997)**

However, other than its application in the assessment and differentiation of uterine anomalies, there is very little evidence demonstrating that 3D ultrasound results in a clinically relevant benefit or negates the need for further investigation. Future work should ensure that 3D ultrasound is compared with conventional imaging in randomized trials where the observer is blind to the outcome, only after which will we truly be able to evaluate its role in an evidence-based manner.(**Neeta Pandit-Taskar, 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)**

Transvaginal ultrasound is often recommended as a preliminary ‘noninvasive’ technique for assessing the endometrium in women with PMB. Unfortunately, it cannot give a definitive answer as to the presence or absence of malignancy, although it can sometimes be helpful in the assessment of uterine polyps. There is no consensus in the literature as to what the cut-off value for normal endometrial thickness should be. It has been reported as anywhere from 4–8 mm. Obviously the lower the cutoff, the higher the sensitivity for detection of endometrial cancers and its precursors but at a cost of lower specificity and increased false positives.

The aim of this study is to evaluate the effectiveness of 3D and color doppler sonography in the diagnosis of postmenopausal bleeding and especially its causes as endometrial carcinoma and polyps.

CHAPTER I

<u>Physics Of 3D Ultrasound</u>

Physics of 3D Ultrasound

Basic principles

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. **(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.**(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.**(B.Downey et al., 1999)**

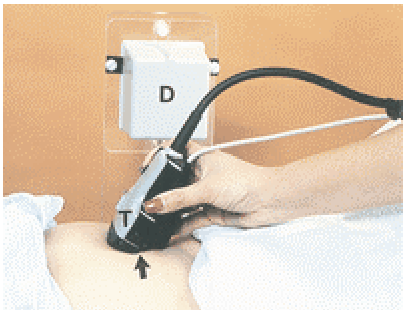

Figure 1. Tracked freehand 3D scanning. (**B.Downey et al., 1999)**

- 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). (**Fenster et al., 1999)**

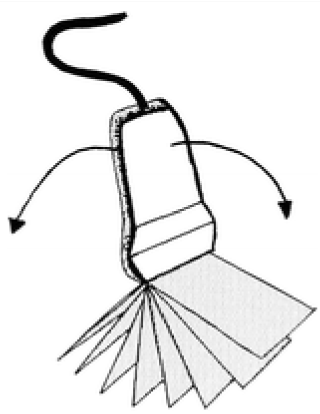

Figure 2. Untracked freehand 3D scanning. Diagram shows how the transducer can be tilted about a fixed point on the skin surface.(**Fenster et al.,1999)**

- Mechanical Assemblies***:***

With mechanical assemblies, the transducer is propelled or rotated mechanically, and 2D images are digitized at predetermined spatial or angular intervals (Fig 3). Although these mechanical transducer attachments are more cumbersome for the user, they also improve the geometric accuracy of the resulting images. To date, their greatest utility has been in intracavitary and intraluminal examinations, in which the area of interest is relatively small and motion artifact is less of a problem. Three different scanning techniques can be used: linear scanning, tilt scanning, and rotational scanning.(**B.Downey et al., 1999)**

With linear scanning, a mechanical assembly moves the transducer in a linear fashion along the patient's skin (Fig 3). This technique has certain advantages; for example, by tilting the transducer away from the vertical plane, 3D color and power Doppler US (which are angle dependent) can be performed. Linear scanning also allows adjustment of the interval between the 2D digitized images for proper sampling and makes 3D reconstruction very fast and efficient because the images are parallel and are separated by a predetermined interval. **(Nelson TR.et al., 1998)**

With tilt scanning, the transducer is tilted about its face, and images are digitized at a predetermined angular interval (Fig 3). The mechanism for tilt scanning is usually quite small, which allows easy handheld manipulations. However, because the digitized images are arranged like a fan, the space between them increases and the resolution decreases with increasing depth. (**Nelson TR.et al., 1998)**

With rotational scanning, the transducer is rotated about its central axis (Fig 3), producing digitized images in a propellerlike arrangement. As a result, the sampling distance increases and the resolution decreases as distance from the rotational axis increases. In addition, the digitized images intersect along the rotational axis, so that any motion creates artifacts at the center of the 3D image. **(Tong S.et al., 1999)**