



Contrast Enhanced Ultrasound in Assessment of Adnexal Masses

Essay

Submitted for partial fulfillment of Master degree in Radiodiagnosis

Submitted by

Ali Osama Hanafy Radwan
(M. B. B. Ch)

Ain Shams University

Under supervision of

Prof. Dr. Nevine Mostafa Ibrahim

Professor of Radiodiagnosis

Faculty of medicine, Ain Shams University

Dr. Ahmed Hussein

Lecturer of Radiodiagnosis

Faculty of medicine, Ain Shams University

Faculty of medicine
Ain Shams University

2014

Acknowledgement

FIRST AND FOREMOST, THANKS TO ALLAH

I would like to express my deepest gratitude and thanks to prof. **Dr. Nevine Mostafa Ibrahim** professor of Diagnostic Radiology, Faculty of Medicine, Ain Shams University; for her continuous kind supervision; generous advices and endless ideas for this work to be achieved. Indeed, it has been a privilege for me to be under her sincere supervision.

I wish to express my deepest appreciation to **Dr. Ahmed Hussein**, Lecturer of Diagnostic Radiology, Faculty of Medicine, Ain Shams University; for his unlimited assistance, kind cooperation, valuable aid and keen supervision.

My appreciations is extended to every person taught me a word in the field of Diagnostic Radiology; I am sure that this had its contribution in this work.

List of abbreviations

AT	Arrival time
AUC	Area under curve
CDFI	Colour Doppler flow index
CE-TVS	Contrast enhanced transvaginal sonography
CEUS	Contrast enhanced ultrasound
CT	Computed tomography
DCE	Duration of contrast effect
Fig	Figure
IEE	Iodipamide Ethyl Ester
MRI	Magnetic resonance imaging
MVD	Microvessel density
PFC	Perfluoro chemicals
PI	Peak intensity
RCNA	Radiological clinic of North America
ROI	Region of interest
TIC	Time intensity curve
TTP	Time to Peak
USCAs	Ultrasound contrast agents

List of figures

No.	Figure	Page
1	Shape and position of the uterus	5
2	Layers of the uterus	6
3	Blood supply of the uterus	8
4	Uterine and ovarian ligaments	10
5	Natural variants of the uterine positions	11
6	Uterine tubes and anatomy	13
7	Normal uterus and vagina during T/V exam	19
8	Normal uterus during transabdominal scan	19
9	Normal ovary during transabdominal scan	21
10	Normal ovary during transvaginal scan	22
11	Simple ovarian cyst	26
12	Corpus luteum by transvaginal scan	27
13	Hemorrhagic cyst by T/V scan	29
14	Subacute Hemorrhagic cyst	30
15	Endometrioma in Transvaginal scan	31
16	Mature cystic teratoma in Transvaginal scan	32
17	Mature cystic teratoma at Transvaginal exam	33
18	Ovarian fibroma by Transvaginal scan	34
19	Complex cystic adnexal mass by T/V scan	36
20	Serous Cystadenocarcinoma by T/V	38
21	Unilocular Solid adnexal mass T/V scan	39
22	Serous cystadenocarcinoma	40
23	Power Doppler of solid adnexal mass	42
24	Hydrosalpinx by T/V scan.	46
25	Peritoneal inclusion cyst	47
26	Pedunculated uterine leiomyoma	48
27	Tubo/ovarian Abscess	50
28	Ovarian hyper stimulation syndrome transabdominal scan	54
29	Transvaginal & Transabdominal Scan technique	55
30	Structure of microscopic bubble	57
31	Contrast agents for ultrasound	59

32	Bubbles and Red blood cells	60
33	Microscopic bubble resonance in relation to Ultrasound frequency	61
34	Tissue harmonic images	63
35	Contrast enhanced quantification parameters	77
36	Color Doppler US images of adnexal masses	78
37	Chronic salpingeal abscess	81
38	Non bleeding endometritis	82
39	Seropapilliferous tumor of the ovary	82
40	CE ovarian fibroma	84
41	CE adenocarcinoma	85
42	CE kinetic analysis	87
43	CE ultrasound thecoma	90
44	CE ultrasound poorly differentiated serous adenocarcinoma	91
45	Correlation of MVD and TIC parameters in ovarian tumors	92
46	T/V CE US endometrioma	93
47	T/V CE US serous cystadenoma	94
48	T/V CE US mature cystic teratoma	95
49	Serous adenocarcinoma	96
50	Endometrial adenocarcinoma	97

List Of Tables

No.	Table	Page
1	Differential diagnosis of adnexal masses	24
2	Diagnostic accuracy of CE US criteria for ovarian carcinoma	86
3	Comparison of TIC parameters between benign and malignant tumors	88

Content

chapter	subject	Page no.
I	Introduction and aim of the work	1
II	Gross anatomy & Ultrasonographic anatomy of the pelvis & adenxa	4
III	Pathology of adenxal masses and their ultrasonographic features	23
IV	Technique of Ultrasonographic examination of the pelvis	55
V	Ultrasound Contrast Agents	57
VI	Role of Contrast Enhanced Ultrasound In Assessment of Adnexal Lesions	73
VII	Summary and conclusion.	102
VIII	References.	105
IX	Arabic summary.	

Introduction

Ultrasound examination is a relatively simple and cheap diagnostic method, and an experienced ultrasound examiner can often confidently and correctly distinguish between benign and malignant pelvic masses on the basis of subjective evaluation of gray scale and color Doppler ultrasound findings (*Valentin, 2012*).

Spectral Doppler sonography and color Doppler ultrasound have been used successfully in the evaluation of adnexal tumor vascularity (*Fleischer et al., 2011*). Although previous studies reported that both spectral Doppler and color Doppler ultrasound could provide clinically useful information related to adnexal tumor vascularity, these imaging modalities have inherent limitations, such as lack of sensitivity to slow flow, angle dependency, and aliasing, which occurs when the Doppler shift frequency exceeds one half the pulse repetition frequency (*Bourne et al., 2007*).

The recent introduction of US contrast agents has totally changed the depiction of specific vascular signs for a definite diagnosis by allowing a marked increase in signal from the vessels, especially with modern non-linear imaging techniques. Contrast-enhanced ultrasound (CEUS) allows an adequate depiction of vessels in relation to the pure intravascular

characteristics of those agents, reinforced by the real-time assessment of the enhancement after contrast injection. The recent availability of this imaging technique for transvaginal applications has allowed physicians to use CEUS in gynecology, such as in ovarian or uterine lesions, for a better assessment of vascular patterns that could play a role in diagnosis management (*Marret et al., 2011*).

Contrast specific imaging adds a high clinical value to ultrasound by allowing the differentiation between normal and pathologic tissue through the dynamic study of the micro- and macro-vasculature, the use of intravascular contrast agents can improve the detection of small vessels and low-volume blood flow (*Gorce et al., 2010*).

The use of a contrast agent improves the clarity of the power Doppler signal and aids identification of vascularized areas of a tumor; malignant lesions contain a significantly higher number of identifiable vessels than the benign lesions, before and after administration of the contrast agent. The differentiation of benign and malignant lesions can be increased by perfusional assessment of the lesion by using contrast agents to improve visualization of tumor vascularity and analysis of peak intensities and time/intensity curves (*Sconfienza et al., 2010*).

To highlight the value & new application of contrast enhanced ultrasonography in evaluation of adnexal mass.

Anatomy

The female genital organs consist of internal and external group. The internal organs which are situated within the pelvis consist of the ovaries, the uterine tubes, the uterus and the vagina. (*Wang et al, 2010*)

The vagina

The vagina is a functional organ of the female reproductive organ system. It extends from the vulva externally to the uterine cervix internally and is located within the pelvis, anterior to the rectum and posterior to the urinary bladder. (*Xie et al. 2011*)

The vagina lies at a 90° angle in relation to the uterus and is held in place by endopelvic fascia and ligaments. It is a potential space that is easily distended. (*Xie et al. 2011*)

Vasculature and lymphatic drainage

The vasculature of the vagina is supplied primarily by the vaginal artery, a branch of the anterior division of the internal iliac artery. Several of these arteries may be found on either side of the pelvis to richly supply the vagina. (*Scully, 2010*)

Lymphatic drainage of the vagina is generally to the external iliac nodes (upper third of the vagina), the common and internal iliac nodes (middle third), and the superficial inguinal and perirectal nodes (lower third). (*Scully, 2010*)

The uterus

The uterus is a pear-shaped organ located in the female pelvis between the urinary bladder anteriorly and the rectum posteriorly (*figure 1*). The average dimensions are approximately 8 cm long, 5 cm across, and 4 cm thick, with an average volume between 80 and 200 mL. The uterus is divided into 3 main parts: the fundus, body, and cervix. (*Ozols et al. 2008*)

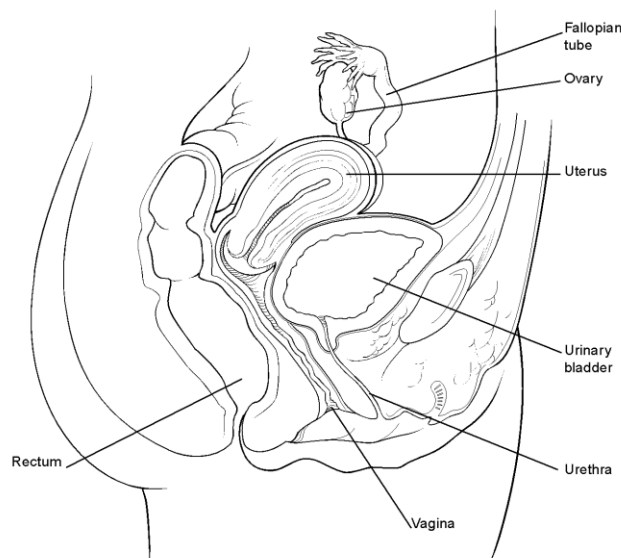


Figure (1): shape and position of the uterus (Patel et al. 2008)

The anatomy of the uterus consists of the following 3 tissue layers (*fig 2*):

- The inner layer, called **the endometrium**, is the most active layer and responds to cyclic ovarian hormone changes; the endometrium is highly specialized and is essential to menstrual and reproductive function
- The middle layer, or **myometrium**, makes up most of the uterine volume and is the muscular layer, composed primarily of smooth muscle cells
- The outer layer of the uterus, **the serosa or perimetrium**, is a thin layer of tissue made of epithelial cells that envelop the uterus. (*Patel et al. 2008*)

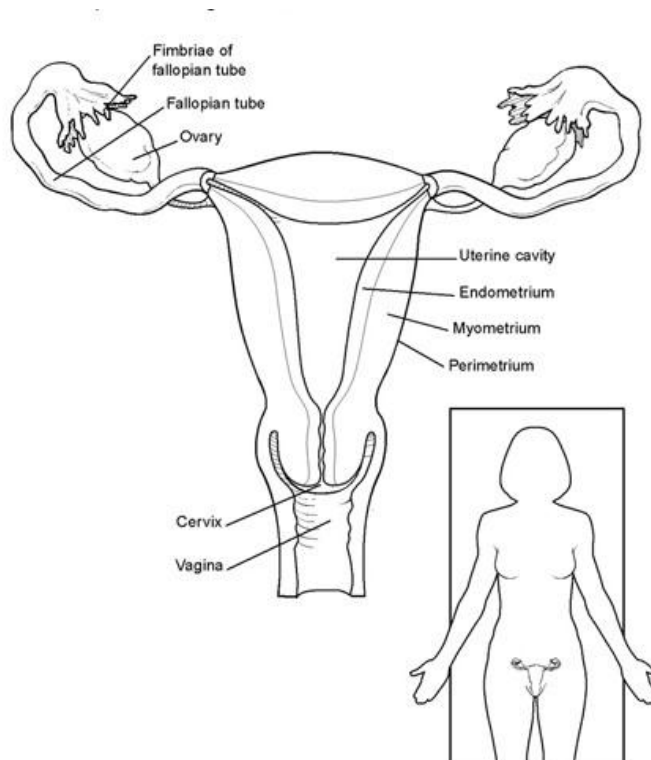


Figure (2): layers of the uterus (Ozols et al. 2008)

Blood is provided to the uterus by the ovarian and uterine arteries, the latter of which arise from the anterior divisions of the internal iliac artery. The uterine artery occasionally gives off the vaginal artery (although this is usually a separate branch of the internal iliac around), which supplies the upper vagina, and the arcuate arteries, which surround the uterus. It then further branches into the radial arteries, which penetrate the myometrium to provide blood to all layers, including the endometrium. (*Demidov et al. 2011*)

Once these vessels reach the endometrial level, they branch into the basal arteries and spiral arteries, which support the specialized functions of each layer. The basal arteries are not responsive to hormones; they support the basal endometrial layer, which provides the proliferative cells for endometrial growth. The spiral arteries supply the functional layer and are uniquely sensitive to steroid hormones (**fig 3**). In ovulatory cycles in which pregnancy does not occur, menses results following constriction of these terminal arteries, causing endometrial breakdown with desquamation of the glands and stroma. (*Dolan et al. 2009*)

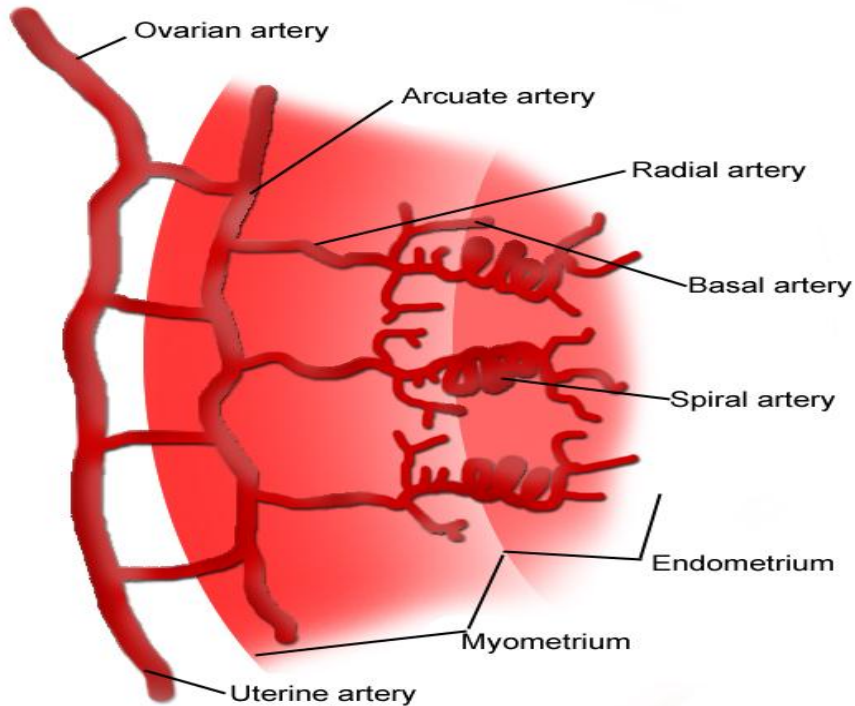


Figure (3): blood supply of the uterus (Dolan et al. 2009)

Ligaments support (figure 4):

The ligaments of the uterus are eight in number: one anterior; one posterior; two lateral or broad; two uterosacral; and two round ligaments. (**Burns, 2009**)

The anterior ligament consists of the vesicouterine fold of peritoneum, which is reflected on to the bladder from the front of the uterus, at the junction of the cervix and body. (**Burns, 2009**)

The posterior ligament consists of the rectovaginal fold of peritoneum, which is reflected from the back of the posterior