



Aradhana Venkatesan  
Gillian Lieberman,

September 2000

# The Radiologic Evaluation of the Ovary

**Aradhana M. Venkatesan, Harvard Medical School Year- IV**  
**Gillian Lieberman, MD**



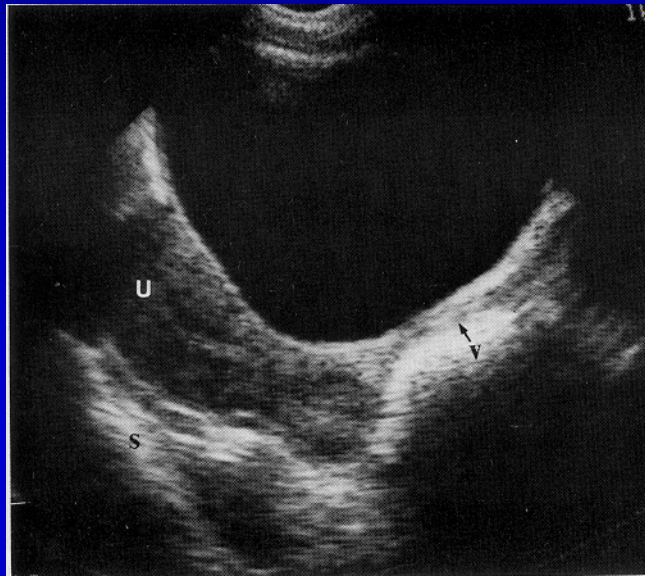
# Menu of Tests

- Trans-abdominal pelvic ultrasound
- Trans-vaginal pelvic ultrasound
- Pelvic MRI- new, promising





# Trans-abdominal Pelvic Ultrasound TECHNIQUE



**Midline longitudinal  
trans-abdominal  
sonogram of the  
uterus (u) and vagina  
(v). S, sacrum**

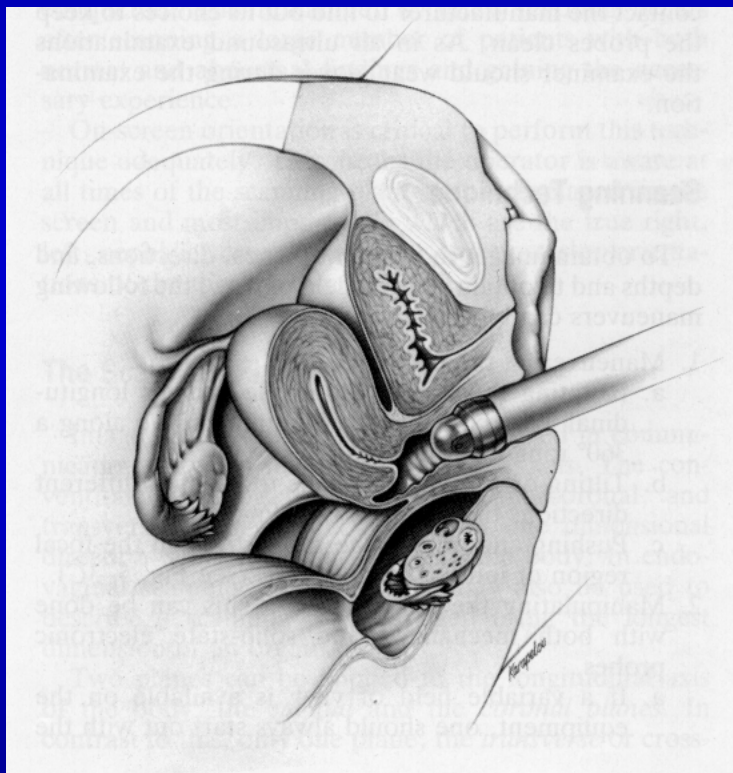
- A distended bladder is essential - this displaces gas-containing loops of bowel and also places the uterus in a horizontal position relative to the beam from the transducer. This allows optimal resolution of the uterus and adnexa.

- When an ovarian mass is detected, a full abdominal ultrasound is performed to look for hydronephrosis, ascites, or omental “cake”



# Trans-vaginal Pelvic Ultrasound TECHNIQUE

Trans-vaginal ultrasound often follows trans-abdominal ultrasound



- The bladder should be non-distended and an organ-oriented rather than an image plane approach should be used.
- Angling the transducer laterally with some rotation, will usually reveal the ovaries.

From Callen, P.W. (Ed.) *Ultrasonography in Obstetrics Gynecology*. WB Saunders and Co., Philadelphia, 1994, p. 53.

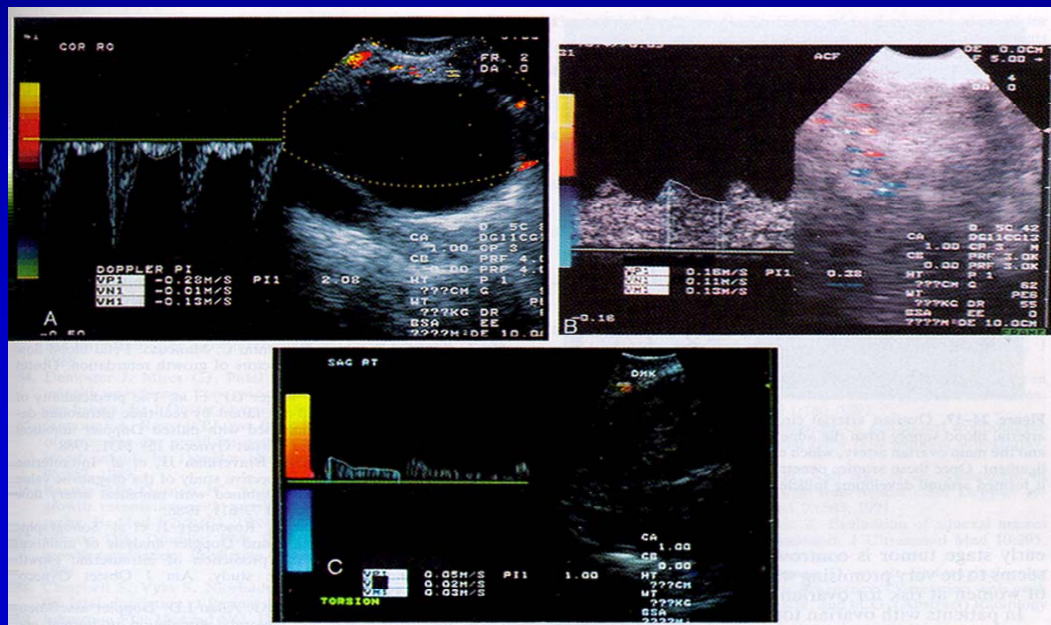


# Doppler Evaluation of Ovarian Masses

- **May differentiate benign from malignant**
- **Ovarian carcinomas as a rule are vascular; tumor angiogenesis results in proliferation of sinusoidal vessels which lack smooth muscle in their vascular walls. This results in a low resistance network that can be analyzed with Doppler imaging and waveform analysis**
- **Inflammatory masses and corpus luteum cysts may demonstrate hypervascularity and low resistance to flow**



# Doppler Evaluation of Ovarian Masses



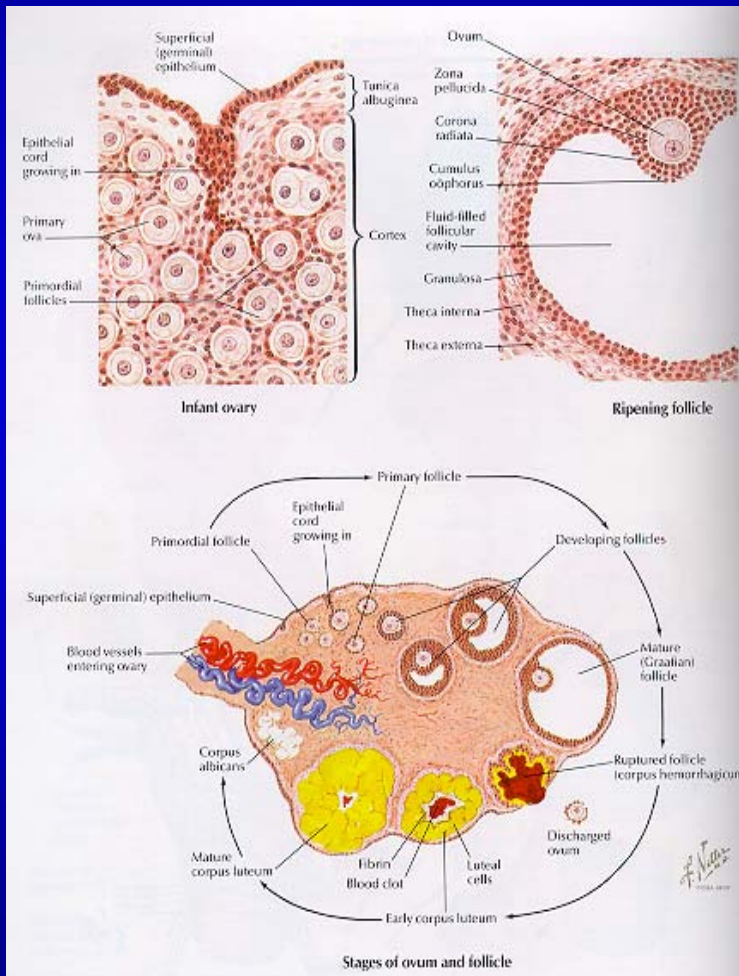
From Callen, P.W.  
(Ed.) *Ultrasonography  
in Obstetrics and  
Gynecology*. WB  
Saunders and Co.,  
Philadelphia, 1994, p.  
521.

**Trans-vaginal color Doppler ultrasound of 3 ovarian masses. A) A benign cystic ovarian mass showing high impedance flow, B) Malignant ovarian dysgerminoma showing low impedance flow, C) Torsed ovary showing minimal capsular flow.**





# Physiology



• During the course of a normal menstrual cycle, a mature Graafian follicle will be seen in mid-cycle, attaining a size of 20-25 mm.

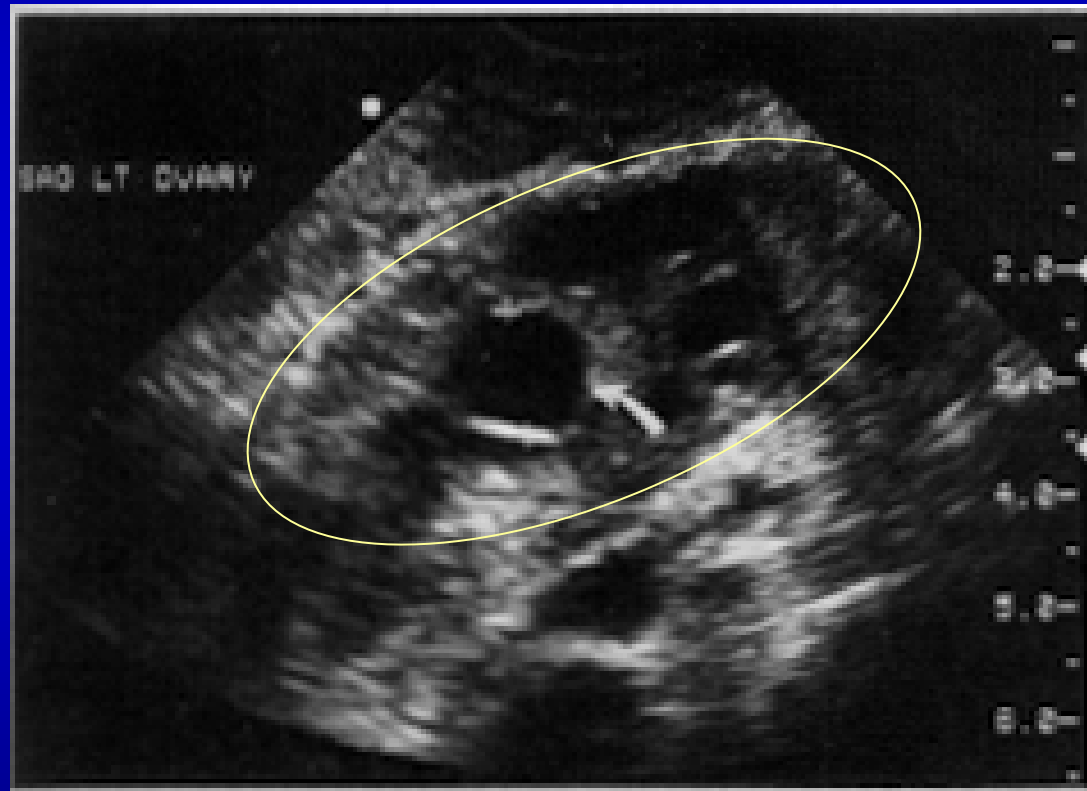
• After ovulation, numerous capillaries from the theca interna spread between the granulosa cells. This can give rise to hemorrhage into the corpus luteum, resulting in a cyst. If small (2.5-3 cm) this is considered consistent with a normal cycle.





# Normal Physiology on Trans-vaginal Ultrasound

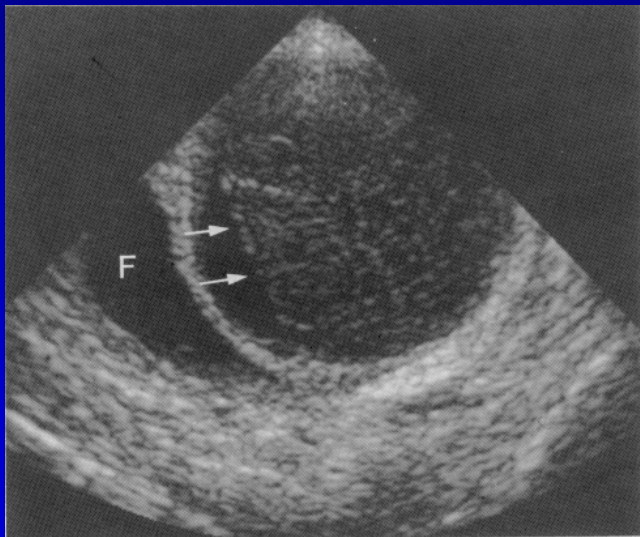
**Sagittal  
sonogram of a  
normal ovary  
in the  
follicular  
phase (day 9)  
with an early  
dominant  
follicle  
(11mm)  
(curved  
arrow)  
surrounded  
by smaller  
follicles.**



From Callen, P.W. (Ed.) *Ultrasonography in Obstetrics and Gynecology*. WB Saunders and Co., Philadelphia, 1994, p. 571.



# Non-Neoplastic Ovarian Cysts



**Echogenic adnexal mass with a mildly thickened wall and enhanced transmission. Margin of internal echoes defies gravity (white arrows) which is typical of clotted blood. This lesion disappeared in 6 weeks without treatment and was likely a corpus luteum cyst.**

- **Most are due to irregular menstrual cycles, resulting in follicular or corpus luteum cysts. Smooth thin walled, unilocular, commonly complicated by hemorrhage.**
- **Other non-neoplastic cysts: theca lutein and serosal inclusion cysts and endometriomas.**
- **Usually resolve spontaneously; only removed if complicated by torsion or rupture.**



# Primary Ovarian Neoplasms

- **Primary tumors of the ovary arise from one of the three ovarian components: surface epithelium, germ cells, and the stroma of the ovary (which includes the sex cords).**
- **Although some ovarian neoplasms are hormonally active, most are non-functional, producing only mild symptoms until they reach a large size. Abdominal pain/distension, urinary or GI tract symptoms due to compressive phenomenon or cancer invasion are the most common presenting symptoms.**

# Primary Ovarian Neoplasms

## OVARIAN NEOPLASMS

### (1993 WHO CLASSIFICATION)

#### Surface epithelial-stromal

#### tumors

#### 1) Serous tumors

Benign

(cystadenoma)

Borderline

Malignant

#### 2) Mucinous tumors,

Benign

Borderline

Malignant

#### 3) Endometrioid

Benign

Borderline

Malignant

#### 4) Epithelial-stromal tumors

#### 5) Clear cell tumors

#### 6) Transitional cell tumors

#### Sex cord-stromal tumors

#### 1) Granulosa-stromal cell

#### 2) Sertoli stromal cell,

androblastomas

#### 3) Sex cord

tumors

#### 4)

Gynandroblastoma

#### 5) Steroid cell tumors

#### Germ cell tumors

#### 1) Teratoma

#### 2) Dysgerminoma

#### 3) Yolk sac tumor

(endodermal sinus tumor)

#### 4) Mixed germ cell tumor

#### Malignant ovarian

neoplasm, NOS

Modified WHO Classification from Cotran R.S., Kumar, V., Collins T. Robbins Pathol. Basis of Dis. (6th ed.), WB Saunders & Co., Philadelphia, 1997, p.1067.



# Broad Categories to Consider With Complex Adnexal Masses

- Hemorrhagic Physiologic cyst
  - Other non-neoplastic ovarian cyst, possibly complicated by hemorrhage
  - Primary ovarian neoplasms, both benign and malignant
  - Ectopic pregnancy
  - Ovarian torsion
  - Tubo-ovarian abscess
- Diagnoses aided by H&P and laboratory data(e.g. WBC count,  $\beta$ -HCG,etc.)



# Features

- Consider whether the mass appears cystic or solid on ultrasound. A thin-walled unilocular cyst is almost always benign. In contrast, a cyst with a mural nodule or septations suggests that it is a neoplasm, though it may still be benign. Solid masses are often ovarian neoplasms.
- There are many types of ovarian tumors, both benign and malignant neoplasms. **As a general rule, neoplastic masses of the ovary are removed because over half of malignant ovarian tumors arise from pre-existing benign tumors.**



# **DDX FOR UNILOCULAR CYSTS**

## **Differential Diagnosis Based on Sonographic Appearance**

### **Very Common:**

**Follicular cyst**

**Corpus luteum cyst**

**Endometrial cyst**

### **Rare:**

**Cystadenoma of low malignant potential**

**Cystadenocarcinoma**

### **Less Common:**

**Para-ovarian cyst,**

**Serous inclusion cyst,**

**Serous cystadenoma**

### **Uncommon:**

**Cystic teratoma**

**Mucinous cystadenoma**

**Cystadenofibroma**

**Large size (>10 cm), irregular thick walls, multi-loculated appearance with septations, mural nodules, solid component is suspicious for neoplasia.**



# DDX FOR SOLID OVARIAN MASSES

## Adnexal leiomyoma

masquerading as a solid  
ovarian mass

## Benign ovarian neoplasms:

Ovarian fibromas

Adenofibromas

Thecomas

Brenner tumors.

## Malignant ovarian neoplasms

especially if large in size, with  
irregular walls, debridinous  
internal echo pattern,  
surrounding ascites, metastatic  
nodules, fixation to pelvic  
sidewall/omentum.





# Benign vs. Malignant Patterns of Ovarian Tumors on Ultrasound

## Benign

**Size <10 cm**

**Smooth walls**

**Unilocular cyst,  
multilocular w/thin septae**

**No debris**

**Mass effect only, mobile**

## Malignant

**Size >10 cm**

**Irregular or poorly defined walls**

**Complex cyst with solid  
component/solid mass**

**Debridinous**

**Fixation to pelvic sidewall or  
omentum, metastatic nodes or  
nodules**



# Patients

**Patient #1: A 32 y.o. F who presented to the BIDMC with LLQ pain of unknown etiology. She had a PMH significant for appendectomy and ovarian cystectomy x 1 (large follicular cyst c/b torsion). A trans-vaginal ultrasound of the left ovary showed the following:**

QuickTime™ and a  
Photo - JPEG decompressor  
are needed to see this picture.



# Patient #1

**Impression: A thin-walled unilocular cystic structure in the left ovary measuring 4.6x3.8x3.0 cm, with low-level internal echoes and no evidence of septations, nodules, solid components.**

**The findings were read as consistent with a hemorrhagic cyst.**

**F/U: On f/u visit one month later, u/s showed complete resolution of the cyst.**



# Patients

**Patient #2: A 34 y.o. F, originally from Ireland, presented to the BIDMC with pelvic pain and increasing abdominal girth. No significant PMH. FH significant for ovarian cancer in paternal grandmother and Hodgkin's disease in paternal uncle. An abdominal and pelvic CT showed abdominal ascites with omental thickening and enlargement of the R ovary to approx 6.6 cm. F/U trans-vaginal ultrasound was arranged and showed the following in the right ovary:**



# Patient #2

## Film findings:

- **6 cm solid irregular adnexal mass (M) inseparable from the R ovary. Marked ascites (A). The uterus was noted to be normal in size and configuration, as was the contralateral ovary.**

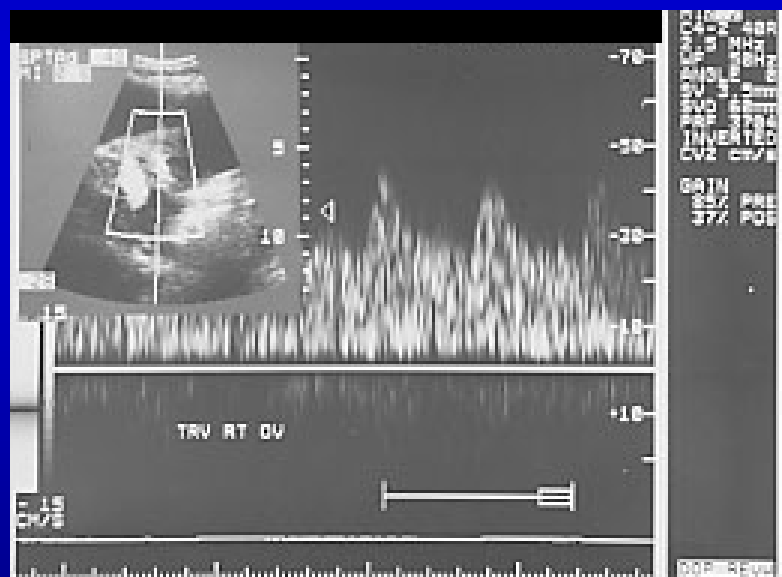


Obtained with permission from the Obstetric and Gynecologic  
Ultrasound Teaching Files, Dept. of Radiology, Beth Israel-  
Deaconess Medical Center, Boston, MA.



# Patients

## Patient #2 (continued) Doppler analysis demonstrated hypervascularity.



Obtained with permission from the Obstetric and Gynecologic  
Ultrasound Teaching Files, Dept. of Radiology, Beth Israel-Deaconess  
Medical Center, Boston, MA.



## Patient #2 continued

- **These findings were read as highly suggestive of malignancy.**
- **The patient underwent an e-lap and TAH-BSO with omentectomy. The pathology report on the L and R ovaries, fallopian tubes, uterus and omentum were positive for poorly differentiated and invasive ovarian cystadenocarcinoma.**
- **Surgery was followed by two cycles of taxol/carboplatin.**
- **Following completion of her second cycle of chemo, the patient elected to move to Ireland to be closer to family. Her prognosis is poor.**



# Additional Radiological Modalities in Ovarian Cancer Surveillance

- **Radiographs- poor**
- **UGI, BE, IVP-poor**
- **CT**
- **MRI-promising**
- **PET-promising**
- **Radio-immunoscintigraphy**





# SUMMARY

- **Pathology of the ovary is difficult to assess clinically so trans-abdominal and trans-vaginal ultrasound is routinely ordered for suspected pathology.**
- **The ovary is a complex and dynamic organ, capable of manifesting a wide array of physiologic cysts, non-neoplastic cysts, benign and malignant ovarian neoplasms.**
- **Sonographic features supporting cysts are unilocular, anechoic, thin walled fluid collections**
- **Sonographic features suspicious for neoplasms are solid, echogenic, thick walled, septated collections. Although some may be benign, they are usually removed as malignancy often complicates benign ovarian neoplasms. Evidence of metastatic disease eg. ascites, liver lesions support malignant origin.**
- **The established imaging modalities of CT and MRI as well as evolving technologies, such as PET and radio-immunoscintigraphy, are available for ovarian cancer staging and surveillance.**



# References

- 1) Callen, P.W.(ED.) Ultrasonography in Obstetrics and Gynecology (3rd). W.B. Saunders and Co., Philadelphia, 1994, pp. 625-660
- 2) Doubilet P. 1999. Transvaginal sonography vs. transabdominal pelvic sonography. American journal of Roentgenology, 173(3): 846
- 3) Green V. 1992. Transvaginal ultrasonography. British Medical Journal. 204(6289):779
- 4) Kosmas C., Kalofonoas H.P., Hird V., Epenetos A.A. 1998. Monoclonal antibody targeting of ovarian cancer. Oncology. 55(5) 435-446
- 5) Kossoff M.B. 1990. Transvaginal Doppler defines pelvic pathology. Diagnostic Imaging (San Fran) 12(9): 96-101.
- 6) Method M.W., Serafini A.N., Averette H.E., Rodriguez M.,Penalver, M.A., Sevin B.U. 1996. The role of radioimmunosintigraphy and CT scan prior to reassessment laparotomy of patients with ovarian cancer. A preliminary report. Cancer. 77(11):2286-2293.
- 7) Netter F.H. Atlas of Human Anatomy. Ciba-Geigy, Summit, N.J. 1989, pp 350-353.
- 8) Putman, C.E., Ravin, C.e. Textbook of Diagnostic Imaging (2nd ed.). W.B. Saunders and Co., Philadelphia, 1994, pp. 2088-2096.
- 9) Sivyer P. 2000. Pelvic ultrasound in women. World Journal of Surgery. 24(2): 188-197.
- 10) Sutton D. (Ed.) Textbook of Radiology and Imaging. Churchill Livingstone, New York, 1998, 1235-1271.



# Acknowledgements

- Beverlee Turner for her support and PowerPoint expertise.
- Larry Barbaras and Ben Crandall our WebMasters.

**The End.**