Radiologic Diagnosis and Staging of Ovarian Cancer

Christina Coleman
Harvard Medical School Year III

Gillian Lieberman, MD
Outline

• Typical Patient Presentation
• Epidemiology of Ovarian Cancer
• Menu of Test Available
  • Ultrasound
  • MRI
  • Computed Tomography
Common Patient Presentation

Ms. D is a 49 yo F who presented to the ED complaining of diffuse abdominal pain and bloating. Her pain is slightly relieved with bowel movements. She denies nausea/vomiting, fever/chills, hematochezia, melena, diarrhea or constipation.

PMH is significant for recent diagnosis of H. Pylori infection being treated with prevpac

Physical exam revealed mild abdominal distention and mild tenderness of RUQ and epigastrium. Guaiac positive stool

Labs were normal except for Hct-34.4 and LDH-301
Patient had abdominal ultrasound to evaluate her for acute cholecystitis
Abdominal US of Liver

Free Fluid in Peritoneum (ASCITES)

Normal Liver
Differential Diagnosis of Ascites

- Elevated Lymphatic Pressure
  - Cirrhosis
  - Heart Failure

- Obstruction of Lymphatics, Portal Vein or IVC
  - Neoplastic
    - Lymphoma
    - Benign tumor
    - Metastatic Disease – Gastric carcinoma, ovarian carcinoma
  - Infection
    - Schistosomiasis
    - Sarcoidosis
    - Tuberculosis

- Thrombosis of IVC or Portal Vein

- Infection or Inflammation (Peritonitis)
  - Abscess
  - Pancreatitis
  - Pelvic Inflammatory Disease
  - Rupture of hollow viscus

- Hypoalbuminemia
Additional Patient History

- Our patient also complained of a weight loss of about 8 – 10 lbs over the last couple of months. Her appetite has been waning.
- Family Hx: mother diagnosed w/ ovarian cancer at age 49, sister had breast cancer at age 35 now 5 years post-menopause, with one son
- Further labs revealed CA-125 elevated 174
Any patient with unexplained ascites and a positive family history of breast and ovarian cancer in addition to elevated CA-125 needs to be worked-up for Ovarian Carcinoma.
What is Ovarian Cancer?

- 80-90% of tumors arise from the surface epithelial-stromal layers of the ovary, usually in the form of a cystadenocarcinoma. Histologic subtypes:
  - serous cystadenocarcinoma (50%)
  - mucinous cystadenocarcinoma (20%)
  - endometrioid carcinoma (20%)
  - clear cell carcinoma (10%)
  - undifferentiated (1%)

- Granulosa cell tumors
- Germ cell tumors: dysgerminomas, immature teratomas, endodermal sinus tumors
- Metastases from breast or gastric carcinoma
Ovarian Cancer Epidemiology

- 5th leading cause of cancer death in women
- ~25,000 new cases each year and 14,500 deaths
- Overall 5-year survival rate is 53%
  - Stage I/II: 80-90% survival rate
  - Stage III/IV: 5-50% survival rate
- 80% of patients present in an advanced stage of disease
Risk Factors

- 10% of cases are hereditary
  - BRCA1 mutation 40-60% lifetime risk of developing ovarian cancer
  - BRCA2 mutation 10-20% lifetime risk
- 90% sporadic
  - older age
  - early menarche or late menopause
  - nulliparity
  - HRT increases risk 1.8x for 10yrs of use
Menu of Tests Available to Diagnose and Stage Ovarian Cancer

- Pelvic Ultrasound
- MRI
- CT
- FDG-PET
Pelvic Ultrasound

- Transabdominal and/or Transvaginal US is the standard for identification and characterization of an adnexal mass
  - 60-97% sensitivity in detecting masses
  - 93-97% of masses can be characterized by sonographic morphology alone
  - 95% positive predictive value for benignity
  - 50-94% positive predictive value for malignancy
US Features of Malignancy vs Benign Cyst

- Ovary volume $> 20\text{cm}^3$ premenopausal or $> 8-10\text{cm}^3$ postmenopausal
- Solid component within mass
- Mural thickening
- Septations $> 3\text{mm}$
- Nodularity
- Papillary projections
- Bilateral masses

All are indications of malignancy
Comparative Patient Transvaginal US of Normal Premenopausal Ovary

Follicles
Comparative Patient Transvaginal US of Ovarian Cyst

Homogenous Anechoic region (Simple Cyst)

Enhanced through transmission
Transvaginal US of Our Patient’s Right Ovary

- Thick wall
- Solid components
- Anechoic cysts
- Nodular
- Large Septum

PACS BIDMC
Transvaginal US of Patient’s Left Ovary

- Septated Cysts
- Solid mass

Dimensions: 3.78cm, 3.11cm
Doppler Ultrasound Helps Distinguish Malignant vs Benign Masses

- Provides information about vascular compliance, vessel density and distribution of vessels within an identified mass
- Tumors have low resistance flow patterns with high systolic to diastolic flow
- Resistive Index (RI) = peak systolic velocity - end diastolic velocity
  \[
  \text{Resistive Index (RI)} = \frac{\text{peak systolic velocity}}{\text{end diastolic velocity}} < 0.4 \text{ abnormal}
  \]
- Pulsatile Index (PI) = peak systolic velocity - end diastolic velocity
  \[
  \text{Pulsatile Index (PI)} = \frac{\text{peak systolic velocity} - \text{end diastolic velocity}}{\text{mean velocity}} < 1.0 \text{ abnormal}
  \]
Color Doppler US of Our Patient’s Right Ovary

Abnormal vascularity within solid mass

6.73cm
2.79cm

Christina Coleman, HMS III
Gillian Lieberman, MD
Ultrasound Diagnosis of Ms D’s ovarian masses

- Large complex right ovarian mass with heterogeneous echogenicity and hyperechoic solid components. Abnormal vascularity seen on color doppler. There is also a 4 by 3cm left ovarian mass. Evidence is highly suspicious for malignancy.

- DDX: primary ovarian tumor, metastases
MRI

- Rarely used for initial diagnosis of ovarian cancer
- Used to characterize masses that are indeterminant or poorly visualized by ultrasound
- Diagnostic predictive value of malignancy is 87-99%
- Ovaries are evaluated with axial T1, axial T2, and sagittal T2-weighted images
- Gadolinium increases detection of malignant masses
- Fat saturation can help distinguish blood from fat on T1
- MRI is also good for detecting local invasion of the cancer
Comparative Patient MRI of Right Ovarian Mass

Heterogenous signal is suspicious for malignancy
Comparative Patient MRI of Myometrial Invasion

http://radiographics.rsnaajnl.org/cgi/content/figsonly/24/1/225
Comparative Patient MR Images showing enhanced metastasis detection with fat-saturation and gadolinium enhancement.

Axial CT

Axial T2-weighted, fat-suppressed MR image

Axial gadolinium-enhanced, T1-weighted, fat-suppressed MR

http://radiographics.rsnaajnl.org/cgi/content/figsonly/24/1/225
Computed Tomography

- Primary modality used for staging ovarian cancer
- Conventional CT: sensitivity 63-79%, specificity 82% for detection of peritoneal implants
- Helical CT: sensitivity 85-93%, specificity 91-96%
- Evaluates extent of tumor, peritoneal implants, lymphadenopathy, and solid organ metastases
- Oral contrast helps to differentiate bowel from serosal and mesenteric mets
- Caveats:
  - Cannot visualize implants < 1cm
  - IV contrast may obscure visualization of calcified mets
Before Looking at the staging of ovarian cancer by CT criteria, we much first understand how the tumor spreads.

- Tumor invades dependent portions of the pelvis
- Peritoneal fluid is seeded by the cancer and spreads it along the abdominal cavity
- Peritoneal fluid flows predominantly on the right, so the right side of the abdomen typically has more metastases
- Blockage of the diaphragmatic lymphatics causes malignant ascites
FIGO Staging Criteria

Stage I: tumor confined to ovaries

Stage II: Local spread of tumor confined to the pelvis

http://radiographics.rsnaajnls.org/cgi/content/figsonly/24/1/225
FIGO Staging Criteria

**Stage III:** peritoneal metastases outside the pelvis or abdominopelvic nodal mets

**Stage IV:** metastasis outside the abdomen, or hematogenesis spread

http://radiographics.rsna.org/cgi/content/figsonly/24/1/225
Potential CT Findings

- Cystic mass lateral to uterus, often bilateral (if lesion is solid, necrosis suggests malignancy)
- Local spread: pelvic side wall, rectum, sigmoid colon, bladder
- Peritoneal spread (Present in 70% of patients at initial diagnosis):
  - Ascites
  - Thickened Omentum (Omental Cake)
  - Plaque-like enhancing soft tissue masses in pouch of Douglas, paracolic gutters, subphrenic space, surface of liver, and surface of small and large bowel
  - Calcified metastases
- Nodal spread: 3 routes
  - Retroperitoneal nodes along ovarian vessels
  - Internal iliac and obturator nodes near broad ligament
  - External iliac and inguinal nodes near round ligament
- Metastases: liver parenchyma, lungs, kidney
Returning to Our Patient, Ms D:

After her ultrasound confirmed bilateral ovarian masses, highly suspicious for malignancy, she had a pelvic and abdominal CT for pre-operative staging.
Patient’s Axial CT – Liver Level

- Ascites
- Peritoneal implant
Comparative Patient CT of Subphrenic Implants

Not visualized on our Patient’s CT but noted during surgery
Patient’s CT – Kidney Level

- Encasement of bowel by tumor
- Omental Cake
- Omental Mass
Patient’s CT a little lower down

Lymphadenopathy (>1cm suggestive of metastasis)

More omental cake
Patient’s CT of Left Ovary

Thickened Bowel Loops

Lt Cystic mass

Rt Cystic Mass

PACS BIDMC
Patient’s CT of Rt Ovary

Sigmoid colon, rectum and uterus encased by tumor

Rt Ovarian Mass
After the CT, Ms D underwent exploratory laparotomy and complete surgical staging.
FDG PET

- Positron Emission Tomography with flourinated deoxy glucose
- Not used for characterization, diagnosis or staging of ovarian masses
- Sensitivity 83-86%, Specificity 54-86%
- False positives with inflammatory processes, some benign tumors, and gastrointestinal activity
- Useful for disease recurrence in patients that have rising CA-125 but negative CT or MRI findings
Surgical Staging

- Murky brown ascites
- Miliary tumor studding right hemidiaphragm
- Omentum replaced by 5cm thick tumor
- Serosal surfaces of the transverse colon, appendix and small bowel were involved
- Tumor coated peritoneum of bladder, uterus, adnexa and cul-de-sac
- Multiple loops of bowel fixed in the pelvis

Stage III C grade 3 papillary serous ovarian carcinoma

http://www.cancerfacts.com/GeneralContent/Ovarian/images/Ovar_SrgclStgng.gif
Summary

If history and physical exam are suspicious for ovarian carcinoma, then the following imaging work-up is recommended:

- Pelvic US: proven to be sensitive and specific enough to detect 60-97% of ovarian masses and characterize them as benign or malignant.
- MRI: reserved for indeterminant US. It can be used for staging, but is more expensive than CT and difficult to assess bowel due to motion artifact. Better visualization of invasion than CT.
- CT: primary modality for staging. Can evaluate tumor invasion, peritoneal metastases, lymphadenopathy, and distant metastasis.
- FDG PET: reserved for diagnosing recurrence of disease.
References


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