Routes of Cancer Dissemination in Metastatic Disease

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Mechanisms of Cancer Spread

• Local Invasion
  – Infiltration, invasion and destruction of surrounding tissue

• Metastasis
  – Lymphangitic Spread
    • carcinomas
  – Hematagenous Spread
    • sarcomas
  – Direct Seeding
    • peritoneum
Lymphangitic Spread

• Most common pathway for dissemination of carcinoma
• Follows natural route of drainage
• Lymphadenopathy
  – Spread and growth of cancer cells and/or
  – reactive hyperplasia
• Can be anterograde or retrograde
Lymphangitic Spread
Patient #1

- Presented the end of 2003 with hemoptysis
- 40 pack-year history of smoking
- Chest Radiograph and CT
Lymphangitic Spread:
Patient #1

PACS, BIDMC
Lymphangitic Spread: Patient #1
Lymphangitic Spread:
Patient #1

- Pleural lymphatics:
  - course over visceral pleural surface
  - drain into hilar nodes at medial aspect of lung
  - anastamose with the parenchymal lymphatics
- Parenchymal lymphatics:
  - interlobular septal and bronchovascular bundles
  - anastamose $\rightarrow$ intralobular $\rightarrow$
    interlobar $\rightarrow$ lobar $\rightarrow$ hilar nodes
- Hilar nodes drain to mediastinum
Lymphangitic Spread: Patient #1

- **RUL** → R paratracheal and anterior mediastinal LN
- **RML and RLL** → subcarinal → R paratracheal and anterior mediastinal LN
- **LUL** → subaortic and paraaortic LN
- **LLL** → subcarinal and subaortic nodes

McLoud et al. Rad Clin N Am 1982; 20: 453-468
Lymphangitic Spread: Patient #1

- Approx. 1 yr. later presents with new cough
- New and enlarged lymphadenopathy
  - Supraclavicular
  - Mediastinal
  - Pretracheal
  - Subcarinal
  - Hilar

PACS, BIDMC
Lymphangitic Spread: Patient #1

Left Subclavicular LN (1.4 x 1.9 cm)

PACS, BIDMC
Lymphangitic Spread: Patient #1

Right Subclavicular LN (1.1 x 1.4 cm)
Lymphangitic Spread: Patient #1

Right Hilar LN (1.5 x 1.5 cm)

Left Hilar LN (2.2 x 2.2 cm)

PACS, BIDMC
Lymphangitic Spread: Patient #1

- Focal Narrowing of L lingular bronchus due to soft tissue mass 2.0 x 2.2 cm at left hilum
Lymphangitic Spread: Patient #1

Imaging Techniques and Staging

- **CT:**
  - PPV = 0.56
  - NPV = 0.83

- **FDG PET**
  - PPV 0.79
  - NPV 0.93

<table>
<thead>
<tr>
<th>Nodal Status</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>N0</td>
<td>No regional LN metastasis</td>
</tr>
<tr>
<td>N1</td>
<td>Ipsilateral peribronchial, hilar, or intrapulmonary LN</td>
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<tr>
<td>N2</td>
<td>Ipsilateral mediastinal and/or subcarinal lymph LN</td>
</tr>
<tr>
<td>N3</td>
<td>Contralateral mediastinal or hilar LN or to ipsilateral or contralateral <strong>supraclavicular LN</strong></td>
</tr>
</tbody>
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Patient #1 – Vertebral Metastases

- Additional Sx: Back Pain
- CT and Bone Scan confirmed metastases to T12 and L pubic ramus
Hematogenous Spread

- Typical metastatic route for sarcomas
- Veins more readily invaded than arteries
  - Portal v. invasion/its tributary → liver metastases
  - IVC invasion/its tributaries → lung metastases
  - Thyroid and prostate cancer can invade invasion paravertebral plexus → lung metastases
Hematogenous Spread: Patient #2

- Papillary Thyroid Carcinoma
  - diagnosed in childhood
  - s/p thyroidectomy
  - routine surveillance for recurrence
Hematogenous Spread: Patient #2

Vascular Invasion and distant metastases:
- 10-15% papillary carcinoma
  - metastases to lung, bone, and mediastinum
- Up to 50% follicular carcinomas
  - Metastases to lung, bone, brain

Hematagenous Spread: Patient #2

5 days s/p I$^{131}$
(CT: 8 small, non-specific pulmonary nodules bilaterally, < 4 mm
Courtesy J Anthony Parker, M.D., Nuclear Medicine, BIDMC

19
Hematogenous Spread: Thyroid Metastases

- $^{131}$I imaging
- Patient with metastatic follicular thyroid carcinoma
- Multiple skeletal and pulmonary metastases.

Sherman. Lancet 2003; 361: 501-511
I\textsuperscript{131} scan: diffuse metastatic pulmonary nodules
Chest radiograph: diffuse nodularity.

www. Auntminnie.com
Dissemination of Ovarian Cancer

• Direct Spread
• Intraperitoneal Dissemination
• Lymphatics
• Hematogenous Spread

FIGO Staging Criteria:
I: confined to ovaries
II: peritoneal metastases
III: extrapelvic peritoneal masses, abdominopelvic nodal masses
IV: metastases outside abdomen and pelvis
Ovarian Cancer: Direct Extension

- Surrounding Pelvic Tissue
  - Fallopian Tubes
  - Uterus
  - Contralateral Ovary
- Bladder
- Rectum
- Pelvic Sidewall
Ovarian Cancer: Direct Extension

- Black Arrow: Irregular border between left ovary and uterus
- Curved arrow: irregular nodularity in surrounding tissues.
- Ascites

Woodward et al. Radiographics 2004; 24 (1): 225-245
Ovarian Cancer: Intraperitoneal Dissemination

- Present in up to 70% patients undergoing staging laparotomy
- Exfoliation of malignant cells into peritoneal fluid, following natural flow of peritoneal fluid in the peritoneal cavity
- Dissemination along mesentery and ligaments
Ovarian Cancer: Intraperitoneal Dissemination

Peritoneal Fluid Circulation:

- Caudal with gravity
- Cephalad with expiration
- Fluid directed by bowel peristalsis and peritoneal reflections and mesenteries

Raptopoulos, Gourtsoyiannis Eur Radiol (2001) 11:2195-2206
Ovarian Cancer: Intraperitoneal Dissemination

Peritoneal Fluid Collections:
• L infracolic → pelvis
• R infracolic → ileoceccal jx
  (overflow to Pouch of Douglas)

Peritoneal Seeding – Main Sites
• pouch of Douglas
• paracolic gutters
• surface of small and large bowel
• greater omentum
• liver surface
• subphrenic space

Raptopoulos, Gourtsoyiannis Eur Radiol (2001) 11:2195-2206
Ovarian Cancer: Intraperitoneal Dissemination

Radiographic Signs:

- plaque like or nodular peritoneal, omental, mesenteric implants
- nodularity, thickening, or enhancement of peritoneal surfaces
- bowel wall thickening or distortion
- capsular liver involvement: smooth, well defined, elliptical, biconvex appearance.
- ascites is non-specific sign, but suggestive
Ovarian Cancer: Intraperitoneal Dissemination

Woodward et al. Radiographics 2004; 24 (1): 225-245


Nodularity or scalloping of liver capsule; no parenchymal invasion
Ovarian Cancer: Intraperitoneal Dissemination

Peritoneal implants in left pericolic gutter

Omental cake: peritoneal implants in greater omentum

Ovarian Cancer: Intraperitoneal Dissemination

Mesenteric Infiltration
Summary

• Local Invasion
  – Example: ovarian cancer

• Metastasis
  – Lymphangitic Spread
    • Example: lung cancer
  – Hematogenous Spread
    • Example: thyroid cancer
  – Direct Seeding
    • Example: ovarian cancer
Summary

• Understanding mechanisms of metastatic spread of cancers can assist the radiologist
  – Evaluation of radiologic studies for evidence of metastatic or recurrent disease
  – Assist surgeon/oncologist in cancer staging
  – Identify primary cancer in patient presenting with metastatic cancer of unknown origin
Acknowledgements

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Ovarian Cancer: Lymphangetic Spread

**Lymphatic drainage routes:**

1. Along ovarian vessels → retroperitoneal paraaortic and paracaval LN
2. Laterally along broad ligament → internal iliac and obturator LN of pelvic side wall
3. Along round ligament → inguinal nodes → groin metastases
4. 80% peritoneal fluid drains via diaphragmatic LN → LAD of anterior diaphragmatic nodes behind sternum and lateral diaphragmatic LN near phrenic nerves

Ovarian Cancer: Lymphangentic Spread

Lymphatic metastases along obturator lymphatic chain

Lymph node metastases in retroperitoneum

Ovarian Cancer: Hematogenous Spread

- Least common metastatic mode for ovarian cancer
- Most common site = liver
  - Left ovarian vein → left renal vein → portal veins
- 2\textsuperscript{nd} most common site = lung
  - Right ovarian vein → IVC → lung metastases
Ovarian Cancer: Hematogenous Spread to Liver