PET/CT Demonstration of Lymphatic Spread of Malignant Pelvic Neoplasms

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This module meets the American Board of Radiology’s (ABR’s) criteria for self-assessment toward the purpose of fulfilling requirements in the ABR Maintenance of Certification (MOC) program.

Please note that in addition to the SA-CME credits, subscribers completing the activity will receive the usual ACCME credits.

After participating in this activity, the radiologist will know the anatomy and nomenclature of the pelvic lymph nodes and the pathways of nodal spread of primary pelvic genitourinary malignancies in both men and women, understand the strengths and weaknesses of 18F-FDG-PET in the assessment of nodal metastases of pelvic malignancies, and comprehend the pathways of nodal metastasis that may help the radiologist to detect the source of an occult primary malignancy in the pelvis.

Key Words: Pelvic Lymph Nodes, Imaging of Pelvic Lymph Nodes, PET/CT Imaging of Metastatic Lymph Nodes, Staging of Pelvic Malignancies

Anatomy of Regional Lymph Nodes of Pelvic Neoplasms

The anatomy of the pelvic lymph nodes is broken into several major groups: inguinal, external iliac, internal iliac, common iliac, para-aortic, and perivisceral (Table 1 on p. 8).

The inguinal nodes lie caudal to the inguinal ligament and are divided into superficial and deep subgroups. The superficial subgroup lies anterior to the superficial femoral vessels, and the deep subgroup lies within the femoral sheath, usually medial to the common femoral vein (Figure 1).1

The superficial inguinal nodes lie anterior to the superficial femoral vessels; the deep inguinal nodes usually lie medial to the common femoral vein.
The external iliac nodes lie near the external iliac vessels and are divided into lateral, middle, and medial subgroups based on their relationship to the external iliac artery and vein (Figure 2). The lateral nodal subgroup, as expected, is located lateral to the external iliac artery. The middle subgroup is between the external iliac artery and vein. The medial subgroup is medial to the external iliac vessels and includes the subgroup of nodes near the obturator internus muscle and obturator vessels, sometimes called the obturator nodes.\(^1\)

Similar to the external iliac nodes, internal iliac nodes lie near the internal iliac vessels. There are four subgroups of the internal iliac nodes: lateral sacral, anterior sacral, anterior, and hypogastric. The lateral sacral nodes are near the paired lateral sacral arteries. The presacral nodes or anterior sacral nodes lie immediately anterior to the sacrum. The anterior nodes lie most anteriorly of the internal iliac nodes, at the origin of the anterior division of the internal iliac arteries (Figure 3). The hypogastric nodes are the most cephalic of the internal iliac nodes.\(^1\)

The common iliac nodes are located more cephalic to the external and internal nodal stations, and they include the same three subgroups as with the external iliac lymph node station: lateral, medial, and middle subgroups. The lateral subgroup is lateral to the common iliac vessels. The medial subgroup is medial to the common iliac vessels. The middle subgroup is within the lumbosacral fossa, posterolateral to the common iliac vessels (Figure 4).\(^1\)

The para-aortic nodes lie near the aorta and inferior vena cava.\(^2\) This nodal station is divided into seven subgroups, with four named by their relationship to the inferior vena cava, and the other three named by their relationship to the aorta (Figure 5).

Perivisceral nodes describe those that are immediately adjacent to their respective pelvic viscera, such as peritoneal or periprostatic.

Figure 1. A 55-year-old man with penile carcinoma. Fused axial image from 18F-FDG PET/CT shows an avid deep inguinal lymph node (arrow) consistent with nodal spread of the penile carcinoma. A deep inguinal node is found within the femoral sheath medial to the common femoral vein (V) and artery (A). A superficial inguinal lymph node (not present) would be anterior to the inguinal ligament and femoral vessels (dashed oval).

Figure 2. A 45-year-old woman with invasive endometrial cancer arising in the uterine corpus. Fused axial image from 18F-FDG-PET/CT shows avid right lateral external iliac (arrow) and left medial external iliac (arrowhead) lymph nodes consistent with nodal spread of endometrial cancer. Note the relationship of nodes to external iliac artery (A) and vein (V). A middle external iliac lymph node (not present) would be between the external iliac artery and vein (dashed oval).
Prostate Cancer

Most commonly, prostate cancer spreads first to the obturator nodes (i.e., medial subgroup of external iliac nodes) (Figure 6) and then continues to the middle and lateral chains of the external iliac nodes. Less commonly, prostate cancer spreads first to the internal iliac nodes. In cancer affecting only one lobe of the prostate, spread is usually ipsilateral.

Prostate cancer most commonly spreads first to the obturator nodes and then continues to the middle and lateral external iliac nodes.

In initial imaging of nodal metastases of prostate cancer for staging, the sensitivity of CT alone for detecting nodal involvement is around 40%. The utility of 18-fluoro-2-deoxyglucose positron emission tomography/CT (18F-FDG-PET/CT) is not well established, with sensitivities ranging from 0% to 50% and specificities ranging from 72% to 90%. The wide range in sensitivities is likely due to small sample sizes and variability in the disease phase. Detection of nodal involvement may be hindered by low FDG avidity of low-grade prostate tumors and by excreted radiotracer within the adjacent urinary bladder. However, imaging with C11-acetate, which assesses lipogenesis and has minimal urinary excretion, demonstrates increased sensitivity for detection of prostate nodal metastasis.

In the evaluation for nodal involvement of recurrent prostate cancer, 18F-FDG-PET/CT demonstrates a sensitivity...
of 35% to 50%.\textsuperscript{5} However, C11-acetate not only demonstrates increased sensitivity for nodal involvement of 80%, it also demonstrates a higher standard uptake value (SUV) compared with FDG. Although the use of C11-acetate in prostate cancer staging and evaluation for recurrent disease has promise, the 20-minute half-life limits its clinical utility.

**Bladder Cancer**

In general, obturator nodes are affected in 75% of patients in whom nodal metastases from bladder cancer are diagnosed.\textsuperscript{1} The specific nodal pathway of spread depends on where the tumor is located in the bladder. Fundal tumors usually metastasize to the obturator and internal iliac nodes via an anterior drainage route (Figure 7). Tumors in the lateral aspects of the bladder usually metastasize to the external iliac nodes, via lateral drainage. Bladder neck tumors usually metastasize via a presacral route to the presacral and common iliac nodes.\textsuperscript{2}

CT is 79% to 90% sensitive for initial staging of bladder metastatic nodal spread.\textsuperscript{3} Imaging with 18F-FDG-PET/CT does not significantly improve sensitivity for detection of regional nodal metastases because of urinary excretion of the radiotracer. However, 18F-FDG-PET/CT improves sensitivity for detection of distant lymph node involvement.\textsuperscript{4} As with prostate cancer, imaging with C11-acetate, which is excreted predominately through the liver, allows better visualization of disease in and around the bladder, and may have potential in imaging of bladder cancer.

**Testicular Cancer**

Metastatic spread of testicular cancer most commonly occurs through the ipsilateral para-aortic pathway, whereas contralateral spread without ipsilateral involvement is rare.

**Metastatic spread from testicular cancer most commonly involves ipsilateral para-aortic nodes; contralateral, without ipsilateral node metastases, is rare.**

Sensitivity and specificity of CT in staging testicular cancer are approximately 40% and 78%, respectively. With the addition of 18F-FDG-PET/CT, these estimates rise to approximately 70% and 100%, respectively (Figures 8 and 9).\textsuperscript{5} 18F-FDG-PET also may be useful after treatment of testicular cancer, as persistent nodal enlargement alone may not indicate presence of active disease. However, with the use of 18F-FDG-PET, differentiation among recurrent tumors and fibrosis or mature teratoma is possible with a sensitivity of 88%.\textsuperscript{5}

**Penile and Vulvar Cancers**

In both penile (Figure 1) and vulvar carcinoma, metastasis most commonly occurs first to the inguinal nodal groups. In both of these types of cancer, regional spread may occur to the bilateral inguinal nodes. When metastasis also occurs to other pelvic nodal groups, including internal iliac or external iliac nodes, this spread is considered regional metastatic disease for penile cancer. However, in vulvar cancer, spread to other pelvic nodal groups is classified as distant metastatic disease.\textsuperscript{1} The presence and extent of nodal involvement plays a large role in treatment and prognosis in each of these types of cancer. Therefore, the detection of involved lymph nodes is extremely important.

The sensitivity of CT alone in detecting metastatic disease in penile cancer is approximately 37%, which in several recent studies has been shown to increase to 80% to 88% using 18F-FDG-PET/CT.\textsuperscript{3} In vulvar cancer, both CT alone and combined 18F-FDG-PET/CT provide low sensitivity for detection of nodal metastatic disease; however, 18F-FDG-PET/CT
The involved lymphatic chain is dependent on the portion of the endometrium involved; corpus lesions tend to metastasize to the external iliac nodes, particularly the obturator subgroup (Figure 2), whereas endometrial cancer with cervical extension tends to metastasize to the common iliac nodes as well as external iliac nodes.

Lymph node involvement of metastatic endometrial cancer is largely dependent on the depth of myometrial invasion of the tumor, with only a 3% rate of nodal involvement in superficial myometrial invasion, compared with 40% in deep myometrial invasion. Both para-aortic and other pelvic lymph node involvement is considered regional nodal spread.

Ovarian Cancer

Initial nodal spread of ovarian cancer may be quite heterogeneous. In most cases, the sentinel node is in the external iliac chain. However, it is not uncommon for initial spread to involve the common iliac, internal iliac, or even para-aortic chains. Bilateral involvement is frequent, and is seen in up to 50% of cases.

Cervical Cancer

Most commonly, cervical cancer spreads first to the external iliac nodes, particularly the obturator subgroup. Less common sites of initial spread include the common or internal iliac nodes (Figure 3). Nodal spread after sentinel node metastasis is unpredictable and may be ipsilateral or contralateral to the sentinel node. Rarely does nodal spread involve the para-aortic nodes without pelvic node involvement.
Cervical cancer spreads most commonly first to the external iliac nodes.

Aside from very small foci of disease, most cervical cancers show intense FDG avidity. Sensitivity of 18F-FDG-PET for initial staging of nodal metastases ranges from 75% to 100%, with a specificity from 92% to 100%. This is superior to either CT or MRI in both sensitivity and specificity.6 False-negative results may relate to small size of tumor deposits and relatively poor spatial resolution of PET. False positives may be related to reactive lymph nodes or misattributing normal bowel or bladder activity to a nodal anatomic correlate. 18F-FDG-PET also is valuable in imaging for recurrent disease, with a sensitivity of 86% to 100% and a specificity of 60% to 94%. Nodal status plays a major role in patient prognosis, with poorer prognosis being associated with both more distant nodal involvement and higher SUV of the affected nodes.9 Based on the most recent ACR guidelines, 18F-FDG-PET/CT has an appropriateness rating for staging of cervical cancer of 8 to 9 depending on tumor size.

Conclusion

Evaluation of nodal metastatic disease is an essential component of both staging and surveillance of many malignancies. This CME activity emphasizes that in some instances, functional imaging with 18F-FDG-PET may be combined with anatomic CT images to improve accuracy in detection of nodal metastatic disease. Practicing radiologists need to be familiar with both the appropriate imaging modalities to assess for nodal metastatic disease and the characteristic locations and appearances of involved nodes. We have reviewed the anatomy of pelvic nodal pathways of spread of malignancies and detailed the common routes of spread of several common genitourinary male and female pelvic malignancies (Table 2 on p. 8). Furthermore, we have reviewed the utility of 18F-FDG-PET/CT in assessing these primary pelvic malignancies for initial staging and surveillance.

References


CME QUIZ: VOLUME 39, NUMBER 2

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Online quiz instructions: To take the quiz online, log on to your account at www.cdrnewsletter.com, and click on the “CME” tab at the top of the page. Then click on “Access the CME activity for this newsletter,” which will take you to the log-in page for http://cme.lww.com. Enter your username and password. Follow the instructions on the site. You may print your official certificate immediately. Please note: Lippincott CME Institute will not mail certificates to online participants. Online quizzes expire on the due date.
1. Which one of the following is the most common initial pelvic nodal site for metastatic prostate cancer?
   A. Inguinal
   B. Internal iliac
   C. Obturator
   D. Para-aortic
   E. Perivisceral

See Reference No. 4 for further study.

2. Which one of the following genitourinary malignancies is most likely to spread initially to isolated para-aortic nodes initially?
   A. Cervical
   B. Penile
   C. Prostate
   D. Ovarian
   E. Endometrial

See Reference No. 6 for further study.

3. Which one of the following is the best imaging modality to diagnose metastatic endometrial cancer?
   A. CT with IV contrast medium
   B. MRI with IV contrast medium
   C. Ultrasound
   D. 18F-FDG-PET/CT
   E. C-11 acetate

See Reference No. 8 for further study.

4. A 66-year-old patient underwent 18F-FDG-PET/CT of the pelvis (Figure 12) for initial staging of a cancer of unknown primary. For which cancer or location would the abnormality (arrowhead) represent the sentinel lymph node? EIA, external iliac artery; EIV, external iliac vein.
   A. Testicular
   B. Penile
   C. Vulvar
   D. Bladder

See Reference No. 2 for further study.

5. Which one of the following statements regarding the anatomy of pelvic lymph nodes is false?
   A. The inguinal nodes lie caudal to the inguinal ligament.
   B. The deep subgroup of inguinal nodes lies within the femoral sheath.
   C. The common iliac nodes lie caudal to the external and internal iliac nodes.
   D. The external iliac nodes lie near the external iliac vessels.
   E. The internal iliac nodes lie near the internal iliac vessels.

See Reference No. 1 for further study.

6. Which one of the following genitourinary cancers shares a pattern of nodal spread similar to penile carcinoma?
   A. Ovarian
   B. Prostate
   C. Bladder
   D. Vulvar

See Reference No. 3 for further study.

7. Which one of the following is the most common pathway of lymphatic spread of testicular cancer?
   A. Inguinal
   B. Internal iliac
   C. Common iliac
   D. Para-aortic

See Reference No. 2 for further study.

8. Medial lymph nodes within the external iliac chain also may be called
   A. inguinal nodes
   B. obturator nodes
   C. sacral nodes
   D. hypogastric nodes
   E. middle nodes

See Reference No. 1 for further study.

9. Which one of the following is considered the sentinel lymph node site for bladder cancer?
   A. Obturator
   B. Anterior sacral
   C. Hypogastric
   D. Para-aortic
   E. Inguinal

See Reference No. 5 for further study.

10. Which one of the following genitourinary malignancies is most likely to spread initially to the inguinal lymph node region?
    A. Testicular
    B. Cervical
    C. Prostate
    D. Vulvar
    E. Endometrial

See Reference No. 7 for further study.
### Table 1. Anatomy of Pelvic Lymph Nodes

<table>
<thead>
<tr>
<th>Major Groups and Subgroups</th>
<th>Usual Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Inguinal</td>
<td></td>
</tr>
<tr>
<td>a. Superficial</td>
<td>Anterior to superficial femoral vessels</td>
</tr>
<tr>
<td>b. Deep</td>
<td>Medial to common femoral vein</td>
</tr>
<tr>
<td>2. External iliac</td>
<td></td>
</tr>
<tr>
<td>a. Lateral</td>
<td>Lateral to external iliac artery</td>
</tr>
<tr>
<td>b. Middle</td>
<td>Between external iliac artery and vein</td>
</tr>
<tr>
<td>c. Medial</td>
<td>Medial to external iliac vessels</td>
</tr>
<tr>
<td>Obturator</td>
<td>Near obturator internus muscle and obturator vessels</td>
</tr>
<tr>
<td>3. Internal iliac</td>
<td></td>
</tr>
<tr>
<td>a. Lateral sacral</td>
<td>Near paired lateral sacral arteries</td>
</tr>
<tr>
<td>b. Anterior sacral</td>
<td>Immediately anterior to sacrum</td>
</tr>
<tr>
<td>c. Anterior</td>
<td>Origin of anterior division of internal iliac arteries</td>
</tr>
<tr>
<td>d. Hypogastric</td>
<td>Most cephalic of internal iliac nodes</td>
</tr>
<tr>
<td>4. Common iliac</td>
<td></td>
</tr>
<tr>
<td>a. Lateral</td>
<td>Lateral to common iliac vessels</td>
</tr>
<tr>
<td>b. Middle</td>
<td>Posterolateral to common iliac vessels</td>
</tr>
<tr>
<td>c. Medial</td>
<td>Medial to common iliac vessels</td>
</tr>
<tr>
<td>5. Para-aortic</td>
<td>Near aorta and inferior vena cava</td>
</tr>
<tr>
<td>6. Perivisceral</td>
<td>Immediately adjacent to their respective pelvic viscera</td>
</tr>
</tbody>
</table>

### Table 2. Nodal Metastasis of Pelvic Malignancies

<table>
<thead>
<tr>
<th>Tumor</th>
<th>Common Initial Nodal Spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Prostate</td>
<td>Obturator</td>
</tr>
<tr>
<td>2. Bladder</td>
<td></td>
</tr>
<tr>
<td>Fundal</td>
<td>Obturator and internal iliac</td>
</tr>
<tr>
<td>Lateral</td>
<td>External iliac</td>
</tr>
<tr>
<td>Neck</td>
<td>Anterior sacral and common iliac</td>
</tr>
<tr>
<td>3. Testicular</td>
<td>Ipsilateral para-aortic</td>
</tr>
<tr>
<td>4. Penile</td>
<td>Inguinal</td>
</tr>
<tr>
<td>5. Vulvar</td>
<td>Inguinal</td>
</tr>
<tr>
<td>6. Ovarian</td>
<td>External iliac</td>
</tr>
<tr>
<td>7. Endometrial</td>
<td></td>
</tr>
<tr>
<td>Corpus</td>
<td>External iliac, particularly obturator</td>
</tr>
<tr>
<td>Cervical extension</td>
<td>Also common iliac</td>
</tr>
<tr>
<td>8. Cervical</td>
<td>External iliac</td>
</tr>
</tbody>
</table>