Imaging Techniques in the Staging of Gynecologic Malignancy

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Radiology has been revolutionized by recent technologic advances that can have an impact on clinical management of gynecologic neoplasms. This rapid change in imaging techniques creates difficult decisions for clinicians in two ways. They must decide how to choose tests that can most appropriately answer diagnostic questions and how to expedite the workup in order to eliminate redundant examinations and decrease expense. This article will attempt to solve these dilemmas by describing the types of radiologic examinations that are currently available. The diagnostic capabilities and the inherent limitations of these examinations will be defined, especially as they relate to the initial staging and the evaluation of recurrence in gynecologic malignancy. With this knowledge, it should be easier to choose which radiologic studies, if any, should be performed on patients with cervical, endometrial, and ovarian malignancies.

Imaging Techniques

There are four main imaging techniques that should be used in current staging of gynecologic malignancy. These are computed tomography (CT), ultrasound (US), lymphangiography (LAG), and barium studies. Magnetic resonance imaging (MRI) is an additional imaging method that has promising potential for staging of pelvic neoplasms. Although experience is preliminary and the procedure is not yet widely available, MRI also will be discussed because it is a new trend in imaging.

With changes in our imaging capabilities, some tests such as the intravenous pyelogram (IVP) are no longer necessary in preoperative assessment of patients with gynecologic neoplasms. The IVP has been used to determine position of the ureters, detect ureteral obstruction, and find any unsuspected urinary anomalies that could interfere with surgery. All this information is better evaluated by CT, which can directly visualize the ureters, retroperitoneum, pelvic sidewalls, and adenopathy. Hillman et al. recently showed that the excretory urogram was inadequate for deter-
mining extension of gynecologic malignant disease.\textsuperscript{1} All patients had operative verification of tumor extent. In this study the IVP had only a 7% true-positive detection rate and 33% sensitivity for tumor spread to the retroperitoneum and adjacent pelvic structures. These results indicate that routine preoperative evaluation by excretory urography is unwarranted.

Of the tests that have been mentioned, CT is the most versatile. This examination can determine the size of the primary lesion, evaluate adjacent structures for contiguous involvement, and assess for more distant spread by directly imaging the pelvic and retroperitoneal nodes as well as the liver. Cross-sectional images of the abdomen are obtained at intervals of 1–2 cm, and scans through the pelvis are done at 1-cm intervals when gynecologic disease is suspected. The bowel is opacified with oral and/or rectal contrast. Vascular structures are enhanced with intravenous contrast, thus making it possible to differentiate vessels from adjacent adenopathy in the obturator, internal and external iliac nodes. Nodes 20 mm or more in diameter are considered abnormal.\textsuperscript{2}

Fourth-generation CT scanners have improved resolution through faster scanning time and smaller pixel size. These improvements make it possible to detect some tumor nodules 10 mm in diameter.\textsuperscript{3} Despite improvements in resolution, CT scanning is considerably handicapped primarily in two ways: 1) it cannot detect a tumor in normal-sized nodes and 2) it often cannot differentiate contiguous disease from local invasion in the bladder and rectum.\textsuperscript{4} These deficiencies in CT capabilities cannot be improved with resolution alone because tissue attenuation values in malignant and benign tissues can be similar. It is primarily this difficulty that decreases the diagnostic accuracy of CT scanning in staging of gynecologic malignancy. These issues will be considered further in later sections dealing with specific diseases.

The other diagnostic studies should be used to supplement CT staging. If nodes are normal by CT, then LAG can allow one to see tumor deposits within normal-sized nodes. Barium enema can readily detect small serosal implants to adjacent bowel that could be overlooked by routine CT scanning.\textsuperscript{5} US has a role in characterization of the primary pelvic mass, particularly with ovarian neoplasms, since it is better than CT in depicting internal architecture, cystic elements, and fine septations. Finally, MRI may be slightly better than CT in differentiating certain types of tissues that could have application particularly in staging of patients with endometrial and cervical carcinoma.

**Cervical Carcinoma**

Accurate staging of carcinoma of the cervix is essential to optimize the results of therapy. Therapy and prognosis vary with the stage. In general, surgery is performed in patients with stages I and IIA malignancy, whereas radiation therapy will be used to treat patients with stage IIB or greater disease.\textsuperscript{6} Clinical staging of early lesions (stages I–IIA) is usually accurate, and the role of radiologic imaging is limited in these patients to the evaluation for the presence of occult hydronephrosis, which would advance the clinical stage and render the patient inoperable.

In patients with advanced stages of cervical carcinoma (stage IIB or greater), the presence of regional or paraaortic lymphadenopathy and bulky local disease needs to be documented in order to optimize the results of radiation therapy and thus the patient's prognosis. A major cause of therapy failure is the presence of tumor involvement of regional or paraaortic lymph nodes or the presence of a bulky local mass.\textsuperscript{7,8} There are three main approaches to evaluating patients for tumor spread: 1) pretreatment staging laparotomy, 2) CT scanning, and 3) lymphangiography. At
our institution, we prefer CT scanning for pretreatment evaluation of these patients. We will discuss the varying roles and results of each of these three approaches to staging.

Pretreatment staging laparotomy has been favored by some for evaluating patients with advanced disease. Correlation of the surgical stage and the clinical stage was studied by Averette et al. in 1972. They found that clinical staging was inaccurate in 38.6% of the patients studied, especially in underestimating the patients who, in fact, had stage IV disease (FIGO classification). The surgical staging modified the therapy considerably. The disadvantages of pretreatment staging laparotomy, however, are the attendant morbidity, expense, and delay in therapy. Because of these disadvantages, other authors advocate pretreatment radiologic evaluation instead of staging laparotomy.

In patients with clinical stage IIB disease and greater, both CT and LAG are useful for detecting paraaortic or iliac lymphadenopathy so that extended field radiation therapy can be administered. Before CT scanning was introduced, LAG was the mainstay of pelvic imaging. The results of LAG in cervical carcinoma show a wide range of sensitivity (28–83%) and specificity (47–100%). LAG remains the only examination for evaluating the internal architecture of a lymph node, allowing detection of metastases in small nodes. A lymphangiogram with normal results, however, may provide false assurances because microscopic foci are not detected nor are all pelvic and paraaortic lymph nodes opacified. Specifically the nodes uncommonly opacified by LAG include the retrocrural nodes and the hypogastric, presacral, and the anterior retroperitoneal nodes. Also, as the number of LAGs performed by radiologists has decreased, the proficiency has lessened of the members of a specific radiology department in performing this technically difficult examination. This should be considered when choosing between CT or LAG for staging in advanced stages.

We feel that CT scanning is the best method for pretreatment staging of patients with cervical carcinoma. CT scanning is noninvasive, and it can detect nodal metastases (Fig. 1). Overall accuracy rates for detection of retroperitoneal adenopathy by CT scanning are 67–83%. Accuracy in detection of pelvic lymph nodes remains a problem. The pelvic lymph nodes are in close relationship to the pelvic vessels, and clearly identifying which structures are nodes and which are vessels is difficult. Asymmetry becomes the primary determinant for pelvic nodal enlargement. It is important to realize that because the CT diagnosis of abnormal lymph nodes is based upon size criteria, not architectural features, false-negative and false-positive examinations occur. Arbitrarily, lymph nodes between 15 mm in diameter and 20 mm in diameter are considered possibly abnormal; those greater than 20 mm are considered abnormal. Fine-needle aspiration biopsy (FNAB) under CT guidance can be performed to evaluate the possibly abnormal or abnormal nodes. FNAB of many abnormal pelvic or retroperitoneal nodes can be performed safely because a safe access can be planned under CT guidance. In patients with aspirations with abnormal results, staging laparotomy may be avoided. Bandy et al. predicted that if all enlarged nodes noted on CT scanning were aspirated, 20% of their patients could have avoided laparotomy.

Parametrial extension of cervical carcinoma excludes the possibility of surgical cure. The normal parametria are imaged as fat-containing structures lateral to the uterus and cervix. Irregular cervical margins, prominent parametrical soft tissue strands, an eccentric parametrical mass, and loss of periureteral fat are associated with parametrical invasion. A recent report by
Vick et al. suggests that parametrial extension of the tumor can be predicted reliably by CT scanning. Unfortunately these same CT findings can be caused by inflammation, prior surgery, radiation, instrumentation, or infection. In our experience, and that of many others, the accurate assessment of parametrial invasion by CT scanning is difficult and represents the largest number of false-negative and false-positive results from scans performed for staging (Fig. 2). FNAB also can be performed in these patients for confirmation of equivocal findings.

A disadvantage of CT scanning is difficulty in diagnosing tumor invasion of the bladder and rectum. Cystoscopy, sigmoidoscopy, and barium enema examination are still necessary to establish tissue diagnosis of bladder or rectal involvement.

The limited role of the excretory urogram in the staging of gynecologic malignancy was discussed previously. One of the main reasons for which the urogram was performed—detection of hydronephrosis—also can be evaluated by CT scanning or renal sonogram. Because the accuracy of the clinical stage in stages I–IIA lesions is good and the ability of CT scans to detect nodal spread is limited in these early lesions, a less-expensive examination such as an excretory urogram or renal sonogram is recommended to exclude hydronephrosis. The presence of hydronephrosis changes the stage to stage III. In our hospital, a renal US is less expensive than an excretory urogram; thus we recommend
FIG. 2. Parametrial extension of cervical carcinoma can be a difficult CT diagnosis. **Top.** A right adnexal mass (arrows) adjacent to the uterus (u) in this patient with cervical carcinoma. Preoperative diagnosis of parametrial involvement was made, but at operation the adnexa were normal. **Bottom.** A patient with cervical carcinoma considered to have a bulky fibroid uterus and normal adnexal regions, but bilateral parametrial extension was evident at subsequent laparotomy.
performing a US to exclude hydronephrosis in patients with clinical stages I–IIA; a pretreatment CT scan is not recommended.

US of the pelvis is of limited utility in this setting. Involvement of the bladder, rectum, or pelvic wall cannot be well defined by US. A recent report of a small group of patients with cervical carcinoma evaluated by MRI and CT suggests that MRI may be slightly better than CT in detecting tumor extension into the pericervical fat (Fig. 3); however, MRI underestimated pelvic adenopathy.15

Recurrent carcinoma usually remains confined to the pelvis, in a central location. Patients who received radiotherapy may have induration of the pelvic floor, causing errors in estimation of disease by pelvic examination. Although CT scanning is useful in evaluating pelvic recurrences, sidewall extension, lymphadenopathy, and the sites of ureteric obstruction, it is often difficult to differentiate the tumor from fibrous or inflammatory tissue. FNAB has been used successfully in differentiating between these possibilities. A recent study compared MRI with CT scanning in this setting.16 Neither imaging technique could differentiate malignant tumors from benign masses reliably. In detecting nodal recurrences, however, CT has proved accurate; and serial CT scans provide reliable measurements of the tumor to assess treatment response after chemotherapy.

In summary, in the staging of cervical carcinoma, stages IA–IIA, the role of radiologic imaging should be limited to either an intravenous urogram or renal sonogram, whichever examination is less costly in an institution, to evaluate for the

**FIG. 3.** MRI shows potential application for imaging cervical carcinoma, since tumor has higher signal intensity (arrow) as demonstrated in this parasagittal T2-weighted image. (Courtesy of Dr. Marcia Fishman, North Shore University Hospital, Cornell University Medical College.)
presence of occult hydronephrosis. In patients with advanced cervical carcinoma, clinical stages IIB or greater, CT scanning should be the first radiologic examination in their pretreatment evaluation. FNAB under CT guidance can be performed to document spread to enlarged lymph nodes. The assessment of the position of the ureters and the presence of obstruction also can be made by the CT scan. The continued routine use of the excretory urogram is not warranted. MRI may prove sensitive enough to detect parametrial extension accurately, although it is still too soon to state this definitively.

**Endometrial Carcinoma**

Use of radiologic imaging in adenocarcinoma of the uterus should vary according to the clinical stage of the disease. When applied appropriately, radiographic studies can be used to determine the extent of the tumor and to assist in certain treatment decisions. As is true with other gynecologic neoplasms, imaging procedures are more important in patients with advanced spread than in those with minimal disease.

For the 75% of patients who present with clinical stages I–II disease (FIGO classification), radiologic imaging is limited to the following: 1) providing accurate measurement of uterine size, 2) evaluating for myometrial invasion, and 3) assessing cervical extension of tumor. The latter two categories represent relatively new areas of research with potential application but not widespread clinical use at this time.

Uterine size is used to differentiate stage IA from stage IB lesions, with uterine enlargement greater than 8 cm considered to be stage IB. Sonography is best for determining uterine size. This examination is inexpensive and readily available, and it can easily assess the uterus even in obese patients, who may be difficult to examine clinically. Sonography is preferable to CT as shown by Nash et al., who found that CT underestimated uterine length by 30–60%. Therefore, if uterine size needs to be confirmed preoperatively, sonography should be used. It can be argued that, because both stages IA and IB endometrial carcinoma are treated by hysterectomy, differentiation between the two stages does not change surgical management. It can determine, however, which patients have pre-operative irradiation, since this is recommended in moderate or poorly differentiated stage IB lesions.

Both CT and MRI can detect myometrial invasion. On CT, with intravenous contrast enhancement, regions involved with endometrial carcinoma appear hypodense as compared with normal myometrium. The appearance is not entirely specific, because leiomyomas can be identical. Preliminary work has shown that MRI may be even more accurate than CT for determining myometrial tumor (Fig. 4). Because deeply penetrating tumors have a high propensity for lymphangitic spread, the demonstration of mural invasion can provide information upon which to base a decision regarding primary exploratory surgery or preoperative irradiation.

Cervical extension of endometrial carcinoma is difficult to diagnose by sonography or CT. Some recent investigations have shown that MRI may be useful in detecting stage II disease, since macroscopic tumor appears hypodense as compared with the normal cervix. No imaging test, including MRI, can detect microscopic disease. Applications of MRI may have practical value in the future, but at present MRI is still an expensive research tool and clinical experience is limited. MRI is also poor at evaluating lymph node enlargement, so this examination will not be able to replace other tests to detect more advanced disease.

Imaging is most useful in advanced endometrial carcinoma. For patients with recurrence or initially presenting stages III and IV disease, CT should be used for treatment planning.
FIG. 4. Both contrast-enhanced CT and MRI can be used to detect myometrial invasion of endometrial carcinoma. **Top.** Parasagittal T2-weighted image of the uterus. High-signal intensity (arrows) from the endometrium, indicating tumor involvement. **Bottom.** Axial view of the uterus in the same patient. Extension of the tumor into the posterior myometrium (arrows). (Courtesy of Dr. Marcia Fishman, North Shore University Hospital, Cornell University Medical College.)
ficacy in detection of pelvic and retroperitoneal adenopathy, as has been described previously. If a solitary enlarged node is seen or if the diagnosis is in question, percutaneous FNAB can be performed for cytologic study and confirmation of malignant cells. Occasionally, very thin patients may lack sufficient retroperitoneal fat to permit optimal visualization of paraaortic adenopathy. In these circumstances sonography is preferable to CT for evaluating the retroperitoneum. LAG should be reserved for patients with stages III and IV disease with nodes of normal size.

For patients with stage IV disease or extrapelvic recurrence, CT scanning can evaluate the liver and retroperitoneum simultaneously, thus detecting easily any liver metastases that may be present. Although CT would not be the cheapest examination, it would be cost-effective because this one study could provide maximum information for evaluation of patients with advanced disease.

CT is also used for detecting bulky disease in the pelvis because of its ability to portray the pelvic sidewalls. There is, however, still an indication for performing a barium enema in conjunction with CT scanning for staging purposes because serosal involvement in the rectum would be better detected by this method.

In summary, imaging techniques clearly fall short of expectations for diagnosing stages I and II endometrial carcinoma. In addition, parametrial or cervical disease, although present, may not always be seen by US or CT. These limitations in detecting disease at initial presentation also apply to small localized pelvic recurrences. The application of current imaging procedures in endometrial carcinoma is mainly for advanced disease and nodal involvement. Detection of adenopathy is best done by CT because it provides exquisite detail of the retroperitoneal and pelvic lymph node distribution. No available test can detect microscopic disease, but LAG and FNAB can be performed to exclude tumor implants in normal-sized nodes (Fig. 5). Documentation of tumor extent then can be used for radiotherapy treatment planning.

**Ovarian Carcinoma**

The patient with ovarian carcinoma often has a pelvic mass; US is usually the initial radiologic examination because the absence of ionizing radiation, especially in younger women, is an important consideration. US has 91% sensitivity in the detection of pelvic masses, but it is rarely specific. All or nearly completely anechoic ovarian lesions are benign. Conversely

![FIG. 5. FNAB of suspicious nodes can be performed readily. In this patient with previous lymphangiogram and suspected recurrence, FNAB confirmed the presence of metastatic tumor.](image_url)
extremely echogenic masses, often demonstrating acoustical shadowing, are likely to be benign teratomas. Aside from these two sonographic patterns, the sonographer cannot predict the malignancy or pathologic type of a tumor on the basis of the sonographic appearance. In general, however, the more echogenic the material within a tumor, the greater the likelihood of malignancy (Fig. 6). Usually US is very accurate in defining the origin of a pelvic mass, although we have observed in our practice a potential pitfall of pelvic sonography: suggestion that a pelvic mass represents an ovarian lesion when, in fact, it is due to a pedunculated uterine fibroid.

Once the diagnosis of ovarian carcinoma is suggested by the pelvic sonogram, the role of radiologic imaging is limited. The best method for assessing the extent of disease is the staging laparotomy; pathologic confirmation is obtained and debulking of the tumor is performed. CT cannot replace surgery as a staging technique because histologic information needs to be obtained and often peritoneal cytologic washings with positive results are the only sign of tumor spread. The size of the largest residual tumor mass remaining after surgery is the most important factor in determining the survival of patients with common epithelial ovarian carcinoma.26 Thus the goal of surgical therapy is to excise as much tumor as possible, yet avoid the possibilities of hemorrhage or fistula formation. Although the surgeon still has to perform a thorough exploratory operation, it is very helpful to assess the disease spread accurately before surgery. Thus we have found radiologic imaging to be useful to alert the surgeon about clinically undetected disease spread and to delineate the known areas of tumor more accurately.

A recent study determined that CT was superior to surgical exploration for detection of intrahepatic metastases and assessment of intrauterine disease.3 Detection of hepatic metastases by CT is important be-

FIG. 6. Sonography is the first imaging test for the evaluation of suspected ovarian masses. This postmenopausal patient had a large pelvic mass (arrows) demonstrated sonographically. The mass has a thick rind with much solid material, most consistent with ovarian malignancy.
cause they may not be evident during surgical exploration, yet their presence places the patient in stage IV. The metastases then can be followed by CT scans after chemotherapy. CT also may detect an abnormal uterus, not apparent at surgery. In one series, seven of seven patients, determined by CT following surgical laparotomy to have possibly abnormal uterus, had confirmation of bulk disease involving the uteri at repeat laparotomy. The CT scan also can detect spread to the omentum. When the greater omentum is diffusely infiltrated by tumor, the so-called "omentum cake", it may be recognized on CT as an extensive soft tissue mass separating the colon or small bowel from the anterior abdominal wall (Fig. 7). These metastases can invade the transverse colon directly.

When colon invasion is suspected preoperatively (change in bowel habits or guaiac-positive stool), a barium enema examination is used for confirmation. It is not radiographically possible, however, to distinguish between malignant invasion of the colon and other diseases such as endometrial implantation on the bowel wall, diverticulitis, or pelvic inflammatory disease. Often the clinical history and physical examination can differentiate among these possibilities.

Early work with MRI in the evaluation of ovarian masses suggests that it will have little use in the evaluation of patients with ovarian carcinoma. In contrast to endometrial and cervical carcinoma, ovarian neoplasms have nonspecific MRI signal intensities.

The role of radiologic imaging before

**FIG. 7.** The omental cake (arrows) of metastatic ovarian carcinoma can be imaged by either sonography or CT. Visualization of the omentum is made easier by the large amount of ascites.
the second-look operation (SLO) is limited to the CT scan. The term second-look operation itself has many interpretations. It is used to refer to patients without evidence of disease in whom there is a question of whether or not to continue chemotherapy. Less often it is used by some to refer to patients with known residual disease who undergo a second operation to excise residual tumor and/or relieve any complications (obstruction, fistula, abscess). For patients in whom the first definition applies, CT is not capable of obviating the need for the second operation. In part this is because of the inherent limitations of CT: 1) it only gives information regarding lymph node size, not histologic characteristics, 2) only under the best of circumstances can metastases less than 10 mm be detected, and 3) residual tumor cannot be differentiated from scar tissue. Also, in some patients with a CT scan with normal results, small metastases only detected by cytologic washings with positive results would be missed without an SLO. Therefore, although CT cannot replace the SLO, it should be used to find areas of residual tumor.

**Conclusion**

Familiarity with the limitations and advantages of the available radiologic examinations will expedite the evaluation of patients with cervical, endometrial, and ovarian carcinoma. Radiologic imaging as described has a definite role in evaluation of common gynecologic malignancies, but the diagnostic approach should be appropriately tailored to the specific clinical questions.

**References**


