Magnetic resonance imaging staging cancer of the uterus

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Endometrial cancer is the fourth most common female malignancy in the UK, with 7,835 cases diagnosed in 2009, accounting for 5% of all female cancers. The estimated lifetime risk of developing uterine cancer is 1 in 46 women. The median age of diagnosis is 70 years and the prevalence is increasing due to an ageing population. Adenocarcinomas constitute 90% of endometrial cancers. The remaining histologic types of endometrial carcinoma include adenocarcinoma with squamous differentiation, adenosquamous carcinoma, clear cell carcinoma and papillary serous carcinoma. Uterine sarcomas are rare and have a separate staging system, as do tumours of the uterine cervix which are beyond the scope of this article.

**Staging**

Imaging criteria for staging endometrial cancer are based on the International Federation of Gynecology and Obstetrics classification (FIGO). The FIGO staging system of endometrial cancer was first proposed in 1988 and is based on surgical and pathological findings. In 2009 the FIGO staging system was updated (table 1). Under the old staging system, stage I disease was divided into IA indicating tumour limited to endometrium, IB indicating tumour invading <50% of the myometrium and IC indicating tumour invading >50% of the myometrium. In the revised system stage I is divided into IA indicating tumour limited to the endometrium or invasion <50% of the myometrium (figure 1) and IB indicating tumour invasion >50% of the myometrium (figure 2). Stage II was previously divided into IIA indicating cervical stromal invasion and IIB indicating cervical stromal invasion. Under the new system endocervical invasion is considered stage I with cervical stromal invasion defined as stage II (figure 3). Stage III remains divided into three with stage IIIA indicating tumour invasion into the serosa or adnexa and IIIB indicating invasion into vagina or parametrium and IIIC previously referring to any lymphadenopathy but now subdivided into IIIC1 indicating the presence of pelvic lymph nodes and IIIC2 indicating the presence of para-aortic lymph nodes. Stage IV remains unchanged and is divided into IVA indicating tumour extension into adjacent bladder or bowel and IVB indicating distant metastases.

**Prognosis**

Five-year survival rates for endometrial cancer vary depending on stage, ranging from 85-96% for stage I to 25% for stage IV disease. The most important prognostic factors are depth of myometrial invasion, nodal status, presence of extrauterine disease and tumour grade. Depth of myometrial invasion is the most important morphologic prognostic factor correlating with tumour grade, extension into the cervix, the presence of lymph node metastases and overall patient survival. The prevalence of lymph node metastases increases from 3% with superficial myometrial invasion to 46% with deep invasion. The prognostic importance of positive cytology from peritoneal washings has been debated and is no longer used for the purposes of staging (formerly T3a, FIGO IIIA). Surgical treatment depends on local extent of disease. Hysterectomy and bilateral oophorectomy are performed in patients at low risk of nodal metastases.

**TABLE 1**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>Tumour confined to the uterus, &lt;50% myometrial invasion</td>
</tr>
<tr>
<td>IB</td>
<td>Tumour confined to the uterus, &gt;50% myometrial invasion</td>
</tr>
<tr>
<td>II</td>
<td>Cervical stromal invasion</td>
</tr>
<tr>
<td>IIIA</td>
<td>Tumour invasion into the serosa or adnexa</td>
</tr>
<tr>
<td>IIIB</td>
<td>Tumour invasion into the vagina or parametrium</td>
</tr>
<tr>
<td>IIIC1</td>
<td>Pelvic lymph node involvement</td>
</tr>
<tr>
<td>IIIC2</td>
<td>Para-aortic lymph node involvement</td>
</tr>
<tr>
<td>IVA</td>
<td>Tumour invasion into bladder or bowel mucosa</td>
</tr>
<tr>
<td>IVB</td>
<td>Distant metastases or inguinal lymph node involvement</td>
</tr>
</tbody>
</table>

**FIGURE 1**

Axial oblique T2 weighted image shows endometrial tumour with less than 50% myometrial invasion consistent with FIGO IA disease.

**FIGURE 2**

Axial oblique T2 weighted image shows endometrial tumour with greater than 50% myometrial invasion Bb disease.
Therefore the challenge for the surgeon is to appropriately select those patients at risk of lymph node metastases.

**MRI**

Although MRI is not universally recognised as a method for definitive staging, it is routinely used in preoperative assessment due to its superior soft tissue contrast resolution. The overall staging accuracy is reported to be between 85% and 93%.\(^9\)\(^-\)\(^{13}\) The sensitivity and specificity of MRI in the assessment of myometrial invasion ranges from 69% to 94% and from 64% to 100% respectively.\(^9\)\(^-\)\(^{13}\) Due to differing surgical practice regarding lymphadenectomy, indications for MRI of the endometrium are not firmly established. There is general consensus that all patients with histological high grade tumours should undergo pre-operative MRI.\(^17\) However, in some centres in the UK all patients with biopsy-proven endometrial cancer will be scanned in order to identify deep myometrial or cervical stromal invasion, thereby identifying candidates for lymphadenectomy at primary surgery.

**Protocol**

Patients are usually instructed to fast for four to six hours and, if necessary, an antiperistaltic agent is given (if not contraindicated) to reduce artefact from small bowel peristalsis. Patients are imaged supine using a pelvic phased array coil. To evaluate the primary tumour and myometrial invasion, axial oblique high resolution T2 weighted spin echo images perpendicular to the long axis of the uterus are performed. To evaluate the pelvis and upper abdomen for lymphadenopathy, axial T1 weighted spin echo images with a large field of view are performed. Sagittal and oblique dynamic contrast-enhanced T1-weighted images with fat saturation are performed to evaluate for myometrial and cervical stromal invasion. The European Society of Urogenital Imaging published guidelines in 2009\(^18\) which are similar to those published by the Royal College of Radiology (RCR) outlined in table 2\(^17\).

**MRI imaging features**

Endometrial tumour is isointense relative to hypointense endometrium on T1-weighted imaging. Tumour demonstrates heterogenous intermediate signal intensity relative to normal endometrium and hyperintense signal relative to normal myometrium on T2-weighted imaging. Depth of myometrial invasion is optimally depicted on conventional T2-weighted imaging. Common pitfalls in assessing depth of myometrial invasion have been reported in the presence of a large polypoid tumour,\(^9\)\(^-\)\(^{13}\) uterine fibroids, adenomyosis\(^20\)\(^-\)\(^{22}\) and endometrial tumour involving the cornu. In these cases dynamic contrast-enhanced imaging and diffusion weighted imaging (DWI) may be helpful in assessing depth of myometrial invasion.

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**TABLE 2**

MRI protocol for imaging of endometrial cancer, current RCR guidelines.

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Plane</th>
<th>Slice thickness</th>
<th>Field of view</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2W</td>
<td>Sagittal (SE)</td>
<td>5 +/- 2mm</td>
<td>Whole pelvis</td>
<td></td>
</tr>
<tr>
<td>T2W</td>
<td>Axial (SE)</td>
<td>5 +/- 2mm</td>
<td>Whole pelvis</td>
<td></td>
</tr>
<tr>
<td>T2W</td>
<td>Oblique axial (SE)</td>
<td>5 +/- 2mm</td>
<td>Small</td>
<td>To view the relationship between the primary tumour and myometrium in a second plane</td>
</tr>
<tr>
<td>T1W + fat sat</td>
<td>Sagittal (GRE) Oblique axial</td>
<td>5 +/- 2mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1W + fat sat + IV contrast medium at 60 and 180 seconds</td>
<td>Sagittal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1W + fat sat + IV contrast medium</td>
<td>Oblique axial</td>
<td>5 +/- 2mm</td>
<td>Standard</td>
<td>Mid-renal hilum to stage lymph nodes</td>
</tr>
<tr>
<td>T1W</td>
<td>Axial</td>
<td>6 +/- 2mm</td>
<td>Medium/large (abdomen)</td>
<td></td>
</tr>
</tbody>
</table>
Dynamic contrast-enhanced MRI (DCEM)

DCEM was first shown to improve the staging accuracy of endometrial cancer in the early 1990s. The imaging features following contrast injection are as follows:

- The normal myometrium enhances avidly in contrast to endometrial tumour.
- Maximum contrast between myometrium and tumour occurs 50-120 seconds after contrast injection and this is the most important phase for accurate assessment of myometrial invasion.

When interpreted with T2-weighted imaging, DCEM has a diagnostic accuracy approaching 98% for assessing myometrial invasion.

However there are a number of studies showing no improvement in staging accuracy with contrast.

At present, the European Society of Urogenital Imaging and the American College of Radiology and RCR recommend the use of contrast in order to optimise accuracy and ease of interpretation. New RCR guidelines, currently in press, are not expected to make this recommendation, based on a recent national audit which found that contrast-enhanced MRI did not improve staging accuracy of MRI of the endometrium.

Diffusion weighted imaging

The added value of DWI is less well established. Endometrial tumour demonstrates restricted diffusion manifesting as high signal on diffusion and low signal on ADC map (figure 5a, 5b). DWI should always be interpreted with the corresponding ADC map to avoid pitfalls such as T2 shine through. The diagnostic accuracy of DWI in assessing myometrial invasion ranges from 62-90%. A recent prospective study has shown that the staging accuracy of DWI is superior to that of DCEM, suggesting that DWI could replace dynamic imaging. At present, DWI remains an adjunct to conventional imaging.

Conclusion

Although MRI is not included in the FIGO staging system it is routinely used in preoperative staging of endometrial cancer. Owing to the superior contrast resolution, MRI can determine depth of myometrial invasion and detect cervical stromal invasion, identifying those patients at risk of lymph node metastases. This enables appropriate referral to specialist gynaecologic oncology centres for radical lymphadenectomy at the time of primary surgery.

References


FIGURE 5a

Sagittal diffusion weighted image shows high signal endometrial tumour consistent with FIGO IA disease.

FIGURE 5b

ADC map shows corresponding low signal.