

Magnetic Resonance Imaging in Endometrial Carcinoma: Assessment of Myometrial Invasion and Local Staging

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Abstract

Background: Endometrial carcinoma is an important gynecologic malignancy in which accurate preoperative assessment of local tumor extent is essential for treatment planning. Magnetic resonance imaging provides high soft-tissue contrast and combines anatomical and functional information for evaluation of the uterus and surrounding pelvic structures.

Objective: This review aims to summarize the role of magnetic resonance imaging in endometrial carcinoma, with particular emphasis on T2-weighted imaging, diffusion-weighted imaging with apparent diffusion coefficient mapping, dynamic contrast-enhanced MRI, and their complementary value in assessing myometrial invasion and local staging.

Conclusion: Multiparametric MRI provides a comprehensive approach to local staging of endometrial carcinoma. T2-weighted imaging defines uterine anatomy, diffusion-weighted imaging and ADC mapping improve tumor conspicuity and functional characterization, and contrast-enhanced imaging can further clarify the tumor-myometrium interface in selected cases. Reliable assessment requires integration of these sequences while recognizing technical and anatomical pitfalls.

Keywords: Endometrial carcinoma; MRI; myometrial invasion; T2-weighted imaging; diffusion-weighted imaging; ADC; dynamic contrast-enhanced MRI.

Introduction

Endometrial carcinoma is an important gynecologic malignancy, and accurate preoperative characterization is required to define the extent of disease and guide management. Global cancer data underline its continuing clinical relevance ⁽¹⁾.

Among the prognostic features considered before treatment, the depth of myometrial invasion is particularly important because deeper invasion is associated with a greater likelihood of extrauterine spread and nodal involvement ⁽²⁾. Cross-sectional imaging, especially MRI, is therefore used as a major decision-support tool for local assessment ⁽³⁾.

Modern MRI evaluation does not depend on a single sequence. Morphologic T2-weighted images are interpreted with functional sequences, particularly diffusion-weighted imaging, and contrast-enhanced imaging when appropriate ⁽⁴⁾. This multiparametric approach aims to improve visualization of the tumor-myometrium interface and the reliability of local staging.

Role of MRI in Preoperative Local Staging

MRI provides high soft-tissue contrast and multiplanar assessment of the uterus, cervix, adnexa, and surrounding pelvic structures. Its major preoperative tasks include identifying the primary tumor, estimating the depth of myometrial invasion, evaluating cervical stromal involvement, and searching for extrauterine disease.

Maheshwari *et al.* ⁽⁵⁾ emphasized the continuing role of MRI in both evaluation and treatment planning for endometrial cancer.

For local staging, acquisition planes should be adapted to the uterine axis rather than relying only on standard body planes. Oblique images perpendicular to the endometrial cavity improve assessment of myometrial thickness and reduce errors caused by uterine flexion or rotation ⁽⁶⁾.

T2-Weighted Imaging

T2-weighted imaging forms the anatomical foundation of pelvic MRI. It delineates the endometrial cavity, myometrium, junctional zone, cervical stroma, and adjacent pelvic organs. Endometrial carcinoma commonly differs in signal intensity from the normal myometrium, allowing the reader to estimate the tumor boundary and its relationship to the uterine wall ⁽⁷⁾.

The most useful T2-weighted planes are sagittal images for global uterine orientation and axial oblique images obtained perpendicular to the long axis of the uterine corpus. This orientation is especially important when the principal question is whether tumor extends through less than or at least half of the myometrial thickness ⁽⁶⁾.

Diffusion-Weighted Imaging and ADC Mapping

Diffusion-weighted imaging adds functional information based on water mobility. Hypercellular malignant tissue often demonstrates high signal on high-b-value DWI with corresponding low signal on the ADC map. The ADC map is essential because high DWI signal alone may represent T2 shine-through rather than true restriction ^(7,8).

DWI can increase tumor conspicuity when the lesion is difficult to separate from the endometrium or myometrium on morphologic images. It is also useful when intravenous contrast is undesirable. Nevertheless, diffusion images have lower spatial resolution and are more vulnerable to susceptibility and motion artifacts, so interpretation should remain linked to T2WI and ADC maps ⁽⁹⁾.

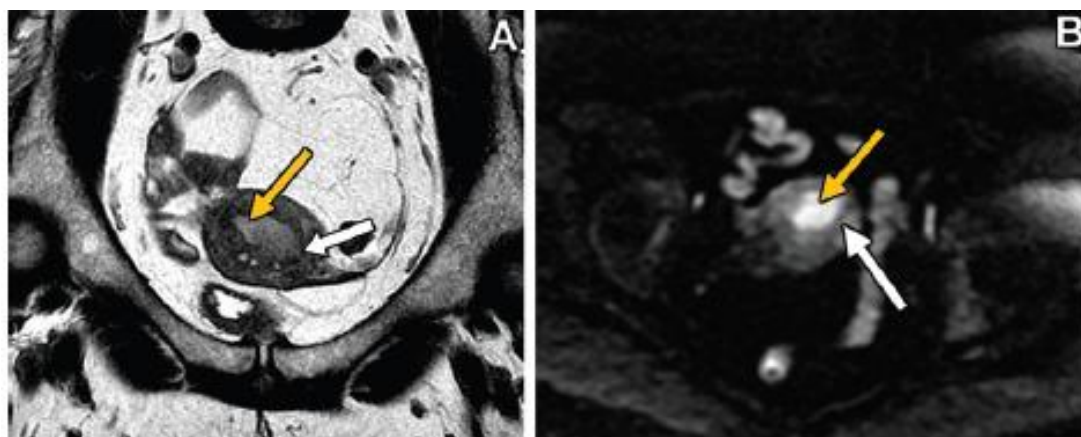


Fig. (1): Axial oblique T2-weighted MR image (A) and diffusion-weighted high-b-value MR image (B) demonstrate a T2 intermediate-signal-intensity mass with restricted diffusion involving the endometrial cavity (gold arrow), with less than 50% myometrial invasion and a preserved outer margin of the junctional zone (white arrow): **Maheshwari *et al.*** ⁽⁵⁾.

Assessment of Myometrial Invasion

The clinically important imaging question is the deepest point at which tumor extends into the myometrium. On T2WI, disruption of the normal inner myometrial interface and extension of intermediate tumor signal into the uterine wall suggest invasion. DWI can support this assessment by showing diffusion-restricted tumor extending beyond the endometrial cavity ⁽¹⁰⁾.

A combined reading strategy is valuable when one sequence is equivocal. Morphologic images provide the anatomic boundary, whereas diffusion images highlight viable tumor. The combination may therefore improve

confidence in distinguishing superficial from deep invasion, particularly when the junctional zone is indistinct (9,10).

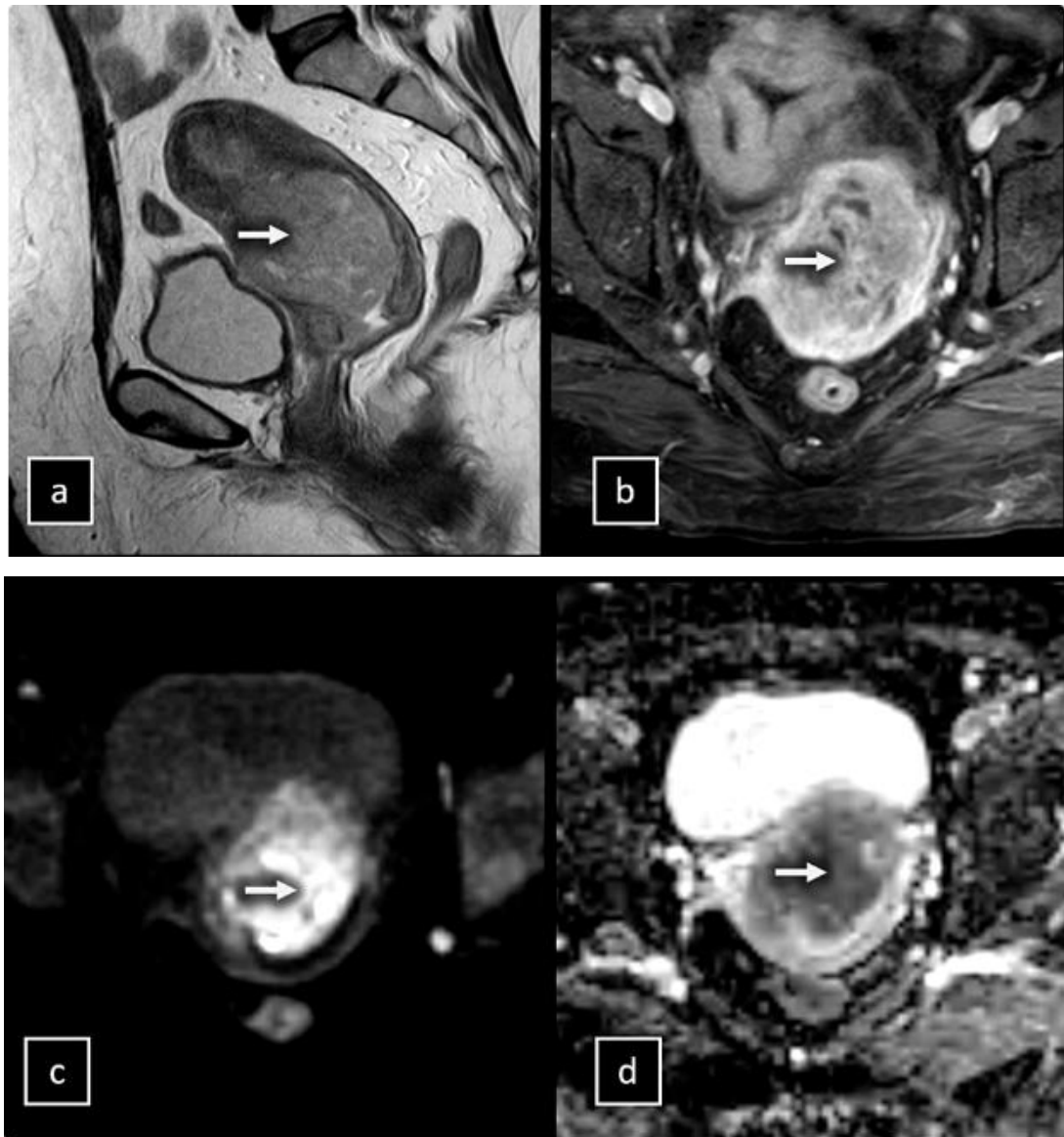


Fig. (2): MRI of a 51-year-old woman with endometrial cancer. (a) Sagittal T2-weighted image (T2WI) demonstrating a large endometrial tumor involving the lower two-third of the endometrium and invading more than 50% of the myometrium (arrow), indicative of deep myometrial invasion. (b) Axial oblique dynamic contrast-enhanced MRI (DCE-MRI) sequence at 120 s, perpendicular to the main uterine axis, showing the large endometrial tumor (arrow) with a hypointense signal compared to the hyperintense myometrium, classified by the observers as deep myometrial invasion. (c) Axial diffusion-weighted imaging (DWI) at a b-value of 1000 s/mm² confirming tumor invasion (arrows) into the outer half of the myometrium. (d) Apparent diffusion coefficient (ADC) map further supporting the presence of deep myometrial invasion. Postoperative histological analysis validated the deep myometrial invasion, classifying the tumor as stage IB: **Beddy et al.** (9).

Dynamic Contrast-Enhanced MRI

Dynamic contrast-enhanced MRI exploits the different enhancement behavior of tumor and normal myometrium. Endometrial carcinoma frequently enhances less avidly than the surrounding myometrium during early phases, which can sharpen the tumor-myometrium interface and assist in difficult cases ⁽¹¹⁾.

Contrast-enhanced imaging may be particularly helpful when T2WI is ambiguous, although it increases examination complexity and requires intravenous contrast. The availability of DWI has strengthened non-contrast assessment, but contrast-enhanced sequences remain useful when a more confident anatomical distinction is needed ^(9,10).

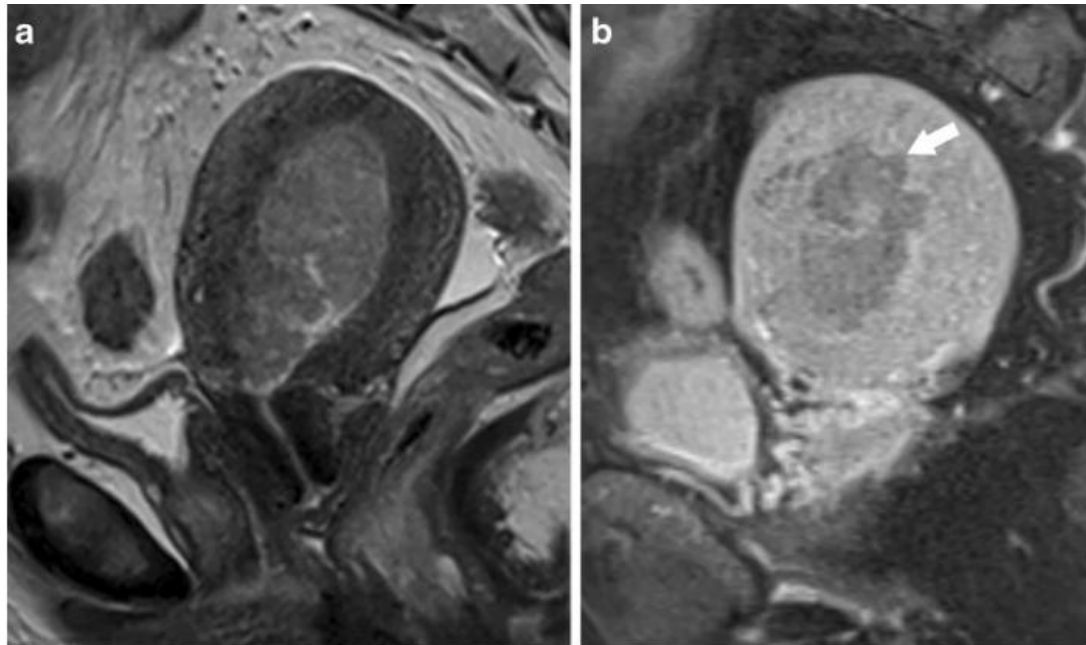


Fig. (3): Endometrial cancer FIGO IA. a Sagittal T2-weighted and b para-sagittal post-contrast images. There is a large volume of tumor within the endometrial cavity. There is invasion of the myometrium, extending to <50% of the myometrial thickness (arrow). The post-contrast image demonstrates the typical bright enhancement of the myometrium with intermediate enhancement of the tumor: **Patel *et al.*** ⁽¹¹⁾.

MRI Criteria Beyond Myometrial Invasion

Local staging also requires evaluation of the cervix and extrauterine structures. Cervical stromal invasion is suggested when the low-signal cervical stromal ring is disrupted by tumor. Assessment should also include the serosal surface, adnexa, vagina, parametrial tissues, lymph nodes, and other visible pelvic sites of disease ⁽⁴⁾.

The radiologist should integrate these findings rather than interpret myometrial invasion as an isolated feature. A structured evaluation of uterine and extrauterine extension supports more consistent preoperative risk stratification and communication with the treating team ⁽³⁾.

Pitfalls and Limitations

Several anatomical conditions can complicate assessment. Adenomyosis may obscure the junctional zone, leiomyomas can distort the cavity and myometrium, cornual tumors are difficult because the myometrium is thin, and large polypoid lesions may compress the uterine wall and simulate invasion. Post-biopsy hemorrhage may also alter signal characteristics ⁽¹²⁾.

Technical quality is equally important. Incorrect imaging planes can lead to inaccurate measurement of myometrial thickness, while motion, thick slices, susceptibility effects, and DWI distortion may reduce confidence. These limitations explain why multiparametric interpretation is preferable to dependence on a single sequence ⁽⁶⁾.

Conclusion

MRI provides a comprehensive framework for local staging of endometrial carcinoma. T2WI supplies the anatomical map, DWI and ADC mapping improve tumor conspicuity and functional characterization, and dynamic contrast-enhanced imaging can clarify the tumor-myometrium interface in selected cases. The most reliable assessment of myometrial invasion results from integrating these sequences while recognizing anatomical and technical pitfalls.

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References

1. **Bray F, Ferlay J, Soerjomataram I *et al.* (2018):** Global cancer statistics GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin.*, 68 (6): 394-424.
2. **Armstrong A, Hurd W, Elguero S *et al.* (2012):** Diagnosis and management of endometrial hyperplasia. *J Minim Invasive Gynecol.*, 19 (5): 562-571.
3. **Reinhold C *et al.* (2020):** ACR Appropriateness Criteria® pretreatment evaluation and follow-up of endometrial cancer. *J Am Coll Radiol.*, 17: S472-S486.
4. **Nougaret S, Horta M, Sala E *et al.* (2019):** Endometrial cancer MRI staging: updated guidelines of the European Society of Urogenital Radiology. *Eur Radiol.*, 29 (2): 792-805.
5. **Maheshwari E, Nougaret S, Stein EB *et al.* (2022):** Update on MRI in evaluation and treatment of endometrial cancer. *Radiographics.*, 42 (7): 2112-2130.
6. **Faria SC, Devine CE, Rao B *et al.* (2019):** Imaging and staging of endometrial cancer. *Semin Ultrasound CT MR.*, 40 (4): 287-294.
7. **Haldorsen IS, Salvesen HB (2012):** Staging of endometrial carcinomas with MRI using traditional and novel MRI techniques. *Clin Radiol.*, 67 (1): 2-12.
8. **Fujii S, Matsusue E, Kigawa J *et al.* (2008):** Diagnostic accuracy of the apparent diffusion coefficient in differentiating benign from malignant uterine endometrial cavity lesions: initial results. *Eur Radiol.*, 18 (2): 384-389.
9. **Beddy P, Moyle P, Kataoka M *et al.* (2012):** Evaluation of depth of myometrial invasion and overall staging in endometrial cancer: comparison of diffusion-weighted and dynamic contrast-enhanced MR imaging. *Radiology.*, 262 (2): 530-537.
10. **Deng L, Wang Q, Chen X *et al.* (2015):** The combination of diffusion- and T2-weighted imaging in predicting deep myometrial invasion of endometrial cancer: a systematic review and meta-analysis. *J Comput Assist Tomogr.*, 39 (5): 661-673.
11. **Patel S, Liyanage H, Sahdev A *et al.* (2010):** Imaging of endometrial and cervical cancer. *Insights Imaging.*, 1 (5): 309-328.