From Staging to Prognostication
Achievements and Challenges of MR Imaging in the Assessment of Endometrial Cancer

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KEYWORDS

• Endometrial cancer • MR Imaging • DWI • DCE • Staging

KEY POINTS

- Endometrial cancer incidence is increasing owing mostly to Western lifestyle.
- Preoperative MR imaging helps in the selection of patients who may benefit from minimally invasive surgery.
- The combination of T2-weighted, diffusion-weighted, and dynamic contrast-enhanced MR imaging provides a "one-stop shop" approach for the accurate staging of patients with endometrial cancer.
- Sequences angled perpendicularly to the endometrial cavity are critical to accurately assess the depth of myometrial invasion.

INTRODUCTION

Endometrial cancer is the fourth most common malignancy in women, with more than 60,000 newly diagnosed cases in the United States in 2016.[1] Its incidence is increasing, mainly owing to increased life expectancy and obesity rates.[1,2] Approximately 75% of cases occur in postmenopausal women, with a mean age at presentation of 63 years.[3] Most endometrial cancers are diagnosed at an early stage (80% stage I), with 5-year survival rates of more than 95%.[3]

Endometrial cancer is staged surgically using the International Federation of Gynecology and Obstetrics (FIGO) system. The standard surgical staging procedure consists of hysterectomy, bilateral salpingo-oophorectomy, lymph node dissection, peritoneal washing, and omental biopsies.[4] However, although the FIGO stage correlates with prognosis, preoperative staging is essential

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to tailor treatment. Indeed, early stage patients may be treated appropriately with minimally invasive surgery and without lymphadenectomy.[5,6] This approach leads to reduced morbidity and shorter duration of hospital stay, with an outcome comparable to the standard, more extensive staging procedure.[7–9] The effective implementation of this management approach relies on accurate preoperative staging.

MR imaging is the imaging modality of choice to determine the depth of myometrial invasion preoperatively, which in turn correlates with tumor grade, presence of lymph node metastases, and overall survival.[10,11] MR imaging is recommended by the American College of Radiologists[12] and the European Society of Radiology for preoperative endometrial cancer staging.[10] The combination of T2-weighted imaging (T2WI), dynamic contrast-enhanced (DCE) MR imaging, and diffusion-weighted imaging (DWI) offers the best diagnostic accuracy in staging of endometrial cancer.[13]

In this review, we emphasize the advantages and challenges of MR imaging staging of endometrial cancer, especially focusing on the MR imaging acquisition protocol and the role of DWI and DCE MR imaging.

PATIENT POPULATION AND TUMOR TYPE

Incidence and Risk Factors

Endometrial cancer is the most common gynecologic cancer in North America (**Box 1**).[1] Furthermore, the number of cases is projected to increase by 55% in the United States between 2010 and 2030.[14] The increasing incidence is thought to be mainly related to the Western lifestyle and obesity in particular.[15,16] Obesity increases estrogen production via its aromatization in adipose tissues.[16,17] Diabetes mellitus is associated with an increased risk, probably related to concurrent obesity, although an independent association between diabetes and endometrial cancer has been reported.[18,19] Nulliparity and infertility are additional risk factors, including polycystic ovarian syndrome.[20] Other risk factors for endometrial cancer include unopposed estrogen therapy such as tamoxifen, estrogen-producing tumors, and early menarche/late menopause.[15,21,22] Most cases of endometrial cancer are sporadic; however, 5% have an hereditary basis related to the Lynch syndrome.[23] This syndrome is due to germ-line mutations of one of the DNA repair genes MSH2, MLH1, and MSH6.

Box 1
Risk factors for endometrial cancer

Excess estrogen exposure

Exogenous estrogen or estrogen agonists
- Unopposed estrogen therapy
- Tamoxifen
- Estrogen–progestin postmenopausal hormone therapy
- Phytoestrogens

Endogenous estrogen
- Obesity
- Chronic anovulation
- Early menarche and late menopause
- Estrogen secreting tumors

Age

Family history of Lynch syndrome

Associated factors

Nulliparity and infertility

Diabetes

Breast cancer

Tubal ligation

Protective factors

Hormonal contraceptives

Increased maternal age

Smoking

Diet and exercise
- Physical activity
- Tea
- Coffee

Pathogenesis

Endometrial carcinomas have been traditionally divided into 2 subtypes based on prognosis (**Table 1**). Type 1 endometrial carcinomas are estrogen-dependent tumors and include FIGO grades 1 and 2 endometrioid adenocarcinomas. Type 2 endometrial carcinomas include serous papillary, clear cell adenocarcinomas, carcinosarcomas, and FIGO grade 3 endometrioid adenocarcinomas. Type II tumors are not driven by estrogen and tend to present at a higher stage and behave more aggressively. Several genomic and molecular characteristics support this dichotomous classification and have become an integral component of the pathologic evaluation. Type I tumors are associated preferentially with genetic alterations in PTEN, KRAS, CTNNB1, and PIK3CA, whereas serous carcinomas usually harbor TP53 mutations. The Cancer Genome Atlas Research Network has improved the evaluation of the molecular landscape of endometrial cancer