

Original Article

# The accuracy of magnetic resonance imaging for preoperative deep myometrium assessment in endometrial cancer

Wan-Ju Wu <sup>a,b</sup>, Mu-Shein Yu <sup>a,b</sup>, Her-Young Su <sup>a,b,\*</sup>, Ke-Shin Lin <sup>c</sup>, Kai-Li Lu <sup>c</sup>,  
Kuei-Shuei Hwang <sup>a,b</sup>

<sup>a</sup> Department of Obstetrics and Gynecology, Tri-Service General Hospital, National Defense Medical Center, Taipei, Taiwan

<sup>b</sup> Department of Obstetrics and Gynecology, SongShan Branch of Tri-Service General Hospital, National Defense Medical Center, Taipei, Taiwan

<sup>c</sup> School of Public Health, National Defense Medical Center, Taipei, Taiwan

Accepted 25 April 2012

## Abstract

**Objective:** To evaluate the accuracy of preoperative magnetic resonance imaging (MRI) to detect deep myometrial invasion in patients with endometrial cancer.

**Materials and Methods:** We retrospectively reviewed 66 cases of women with endometrial cancer, who underwent preoperative MRI assessment and surgical staging between January 2006 and October 2010. The MRI findings were then compared with the pathology results. The diagnostic accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of MRI in detecting deep myometrium invasion were evaluated.

**Results:** The sensitivity, specificity, accuracy, PPV, and NPV results of MRI for the detection of deep myometrium invasion were 92.52%, 74.35%, 81.81%, 71.42%, and 93.54%, respectively, with a kappa of 0.64. In the postmenopausal group, the values were 100%, 55.5%, 74.19%, 61.9%, and 100%. In the premenopausal women, they improved to 85.7%, 90.47%, 88.57%, 88.71%, and 90.47%. The sensitivity (100%) was better than the specificity (55.56%) in the postmenopausal women. The predictive value was markedly higher in the premenopausal women than the postmenopausal women (85.7% vs. 61.9%).

**Conclusion:** In patients with endometrial cancer, a preoperative MRI contributes to accurate staging, allowing planning for the scale of surgery and preoperative counseling. In our study, the pretreatment identification of myometrium invasion provided the opportunity for small-scale surgery in the premenopausal women with early endometrial cancer. However, for the postmenopausal patients, the standard surgical procedure is indicated even if the degree of myometrium invasion is low.

Copyright © 2013, Taiwan Association of Obstetrics & Gynecology. Published by Elsevier Taiwan LLC. All rights reserved.

**Keywords:** deep myometrium invasion; endometrial cancer; magnetic resonance imaging; premenopausal and postmenopausal women

## Introduction

Endometrial cancer is one of the most common gynecologic malignancies, and its frequency is increasing in the developed world. The International Federation of Gynecology and Obstetrics (FIGO) implemented a surgical staging system for endometrial cancer. The current standard surgical procedure

includes a total hysterectomy, bilateral salpingo-oophorectomy (BSO), and peritoneal cytology. Nodal dissection is advocated when a high risk of nodal metastasis is indicated by the presence of greater than 50% myometrium invasion, cervical extension, extrauterine disease, or visible enlarged lymph nodes. Other issues still remain to be clarified, including the option of radical hysterectomy, the feasibility of ovarian preservation, and the necessity of high para-aortic lymph node dissection [1–3]. A laparoscopic surgical staging operation is considered a good alternative to a laparotomy for endometrial cancer.

In 2009, the FIGO committee revised the classification of endometrial cancer based on the favorable prognosis for

\* Corresponding author. Department of Obstetrics and Gynecology, Tri-Service General Hospital, 325, Section 2, Chenggong Road, Neihu District, Taipei, Taiwan.

E-mail address: [crystal.835@yahoo.com.tw](mailto:crystal.835@yahoo.com.tw) (H.-Y. Su).

patients with the disease at the stages formerly classified as IA and IB. Now, Stage IA is defined as involvement of the endometrium and/or less than 50% myometrial invasion and Stage IB as involvement of  $\geq 50\%$  of the outer myometrium [4–6].

The pelvic magnetic resonance imaging (MRI) has been established for use in assessing the depth of myometrial invasion because of its multiplanar capacity and its excellent resolution of soft contrast. Preoperative MRI has been suggested as an alternative to surgical staging to guide the decision regarding the need for a lymphadenectomy and planning the scale of surgery [7]. In the present study, we reviewed the MRI reports and compared the radiology and pathology results to evaluate the accuracy of preoperative MRI in assessing deep myometrium invasion.

## Materials and methods

### Patients

This retrospective study reviewed patients with endometrial cancer who underwent preoperative surveillance included MRI and surgical staging between January 2006 and October 2010 at Tri-Service General Hospital, Taipei. The study had the institutional approval. A total of 76 patients were identified. Ten patients were excluded because of endometrial cancer detected after hysterectomy. The study population consisted of 66 patients with endometrial cancer who were diagnosed by endometrial biopsy and underwent preoperative evaluation, including MRI, between endometrial biopsy and the staging operation. The mean age was 51 years (range: 37–72 years). There were 35 premenopausal and 31 postmenopausal women in the series. Sixty-three patients had endometrioid adenocarcinomas, one a clear cell carcinoma, one a neuroendocrine adenocarcinoma, and one tumor was of uncertain histology because no residual tumor was detected in the surgical specimen (Table 1).

### Methods

MRI was performed before each surgery using a 1.5-T superconducting unit (Vision or Symphony; Siemens, Erlangen, Germany) or 1.5-T unit (Sigma EXCITE HD; GE Medical Systems, Milwaukee, WI) with a phased array coil. Myometrial invasion was evaluated according to published criteria based on the T2-weighted image (T2W) and a dynamic T1-weighted MRI. When the junctional zone was intact, the tumor was considered noninvasive (Fig. 1). In the dynamic films, disruption or irregularity on the subendometrial enhancement was indicative of myometrium invasion (Fig. 2). When the signal intensity of the tumor by either T2W or dynamic study penetrated more than half of the myometrium, it was considered deep myometrium invasion (Fig. 3). All assessments were carried out by three radiologists.

All patients underwent surgical staging after preoperative evaluation. Most patients underwent the standard procedures, consisting of a hysterectomy, BSO and pelvic, and a para-

Table 1

Summary of patient's characteristics.

Characteristics	Patients ( <i>n</i> = 66)
Age	51 (Range: 37–72)
Histology	
Endometrioid adenocarcinoma	63
Grade 1	22
Grade 2	30
Grade 3	11
Neuroendocrine adenocarcinoma	1
Clear cell	1
Uncertain	1
Procedure performed	
TAH	17
Extrafascial hysterectomy	43
LAVH	5
BSO	64
LND	66
Exp. Lap	55
Laparoscopic surgery	7
Robotic surgery	3

aortic lymphadenectomy through laparotomic, robotic, or laparoscopic routes. In two low-risk patients, the ovaries were preserved. The surgical staging results were compared with the preoperative findings on the MRI. Assessments of the premenopausal and postmenopausal groups were based on the 1988 and 2009 FIGO classification. The accuracy, sensitivity, specificity, positive predictive value, and negative predictive value of MRI for determining the deep myometrium invasion were calculated using standard statistical formulas. Data were analyzed using SPSS statistical software, version 16.0 (SPSS Inc., Chicago, IL, USA).

## Results

Of the 66 women, histological evaluation demonstrated that 11 patients had no myometrial invasion, 28 patients had less than 50% myometrial invasion, and 27 had greater than 50%

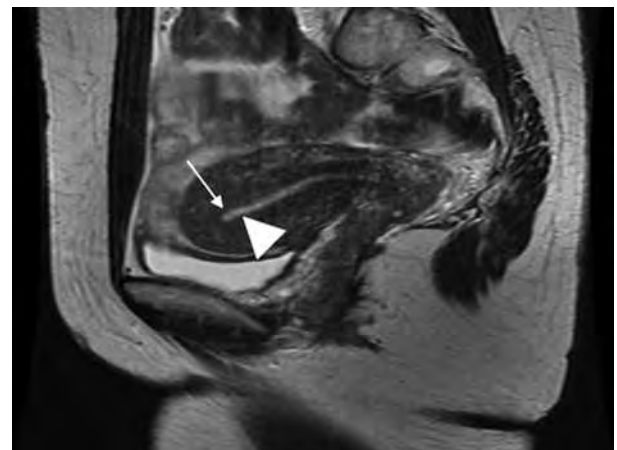


Fig. 1. Superficially invasive endometrial cancer in a 41-year-old premenopausal woman. Sagittal T2-weighted MR image reveals relatively less enhancement of a lesion in the fundal cavity (arrowhead) with an intact junctional zone (arrow).

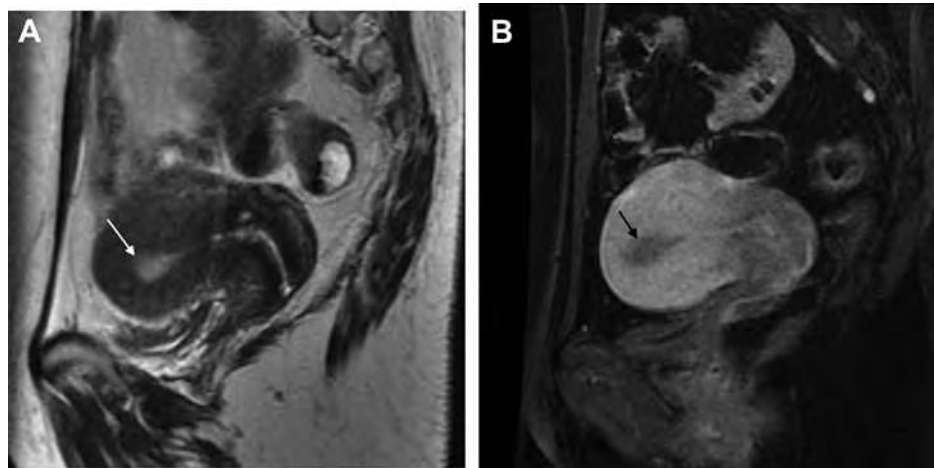


Fig. 2. Stage IA endometrial cancer in a 53-year-old premenopausal women. (A) Sagittal T2-weighted MR image shows blurring of the junctional zone (arrow). (B) Dynamic T1-weighted MR image shows a hypointense lesion with irregularity of the subendometrial enhancement (arrow).

myometrium invasion. Lymph node involvement was observed in 10 patients. Of those, nine had pelvic lymph node metastasis alone, and one had para-aortic lymph node involvement. Tumor invasion of greater than 50% of the myometrium was observed in all 10 patients, including two with cervical involvement.

Using the 1998 FIGO classification, the histology evaluation revealed that 11 women had Stage IA tumors, and 28 Stage IB, 13 Stage IC, two Stage IIB, two Stage IIIA, and 10 Stage IIIC tumors. Thirty patients had a correct diagnosis by MRI, meaning that the accuracy of the MRI assessment was 45.45%, 57.14% for premenopausal patients, and 33.33 % for postmenopausal patients.

When the 2009 FIGO staging system was used, the final histology showed 39 Stage IA tumors, and 13 Stage IB, two

Stage II, two Stage IIIB, nine Stage IIIC1, and one Stage IIIC2 tumors. Forty of the 66 women were correctly staged by MRI, which implies that the accuracy increased to 60.67%, 65.71% in the premenopausal group and 54.84% in the postmenopausal group.

The MRI suggested <50% myometrium invasion in 46.96% ( $n = 31$ ) of the patients and >50% myometrial invasion in 53.03% ( $n = 35$ ) of patients. Twelve patients had enlarged lymph nodes detected by MRI (Table 2). The sensitivity, specificity, accuracy, positive predictive value (PPV), and negative predictive value (NPV) of the MRI for detecting deep myometrium invasion are shown in Table 3.

Discussion

Preoperative MRI has been suggested as an alternative to surgical staging for assessing the severity of endometrial cancer and identifying patients with a high risk of nodal metastasis. The 2009 FIGO staging system uses no or <50% myometrium invasion to separate Stages IA and IB. Stage II is defined by cervical stromal invasion. Therefore, the use of the 2009 FIGO classification rather than the 1998 classification increases the accuracy of an MRI for staging patients because there are fewer staging categories.

The depth of myometrium invasion is one of the risk factors in endometrial cancer, correlating with the prevalence of lymph node metastases. Manfredi et al reported that conventional MRI combined with contrast-enhanced dynamic

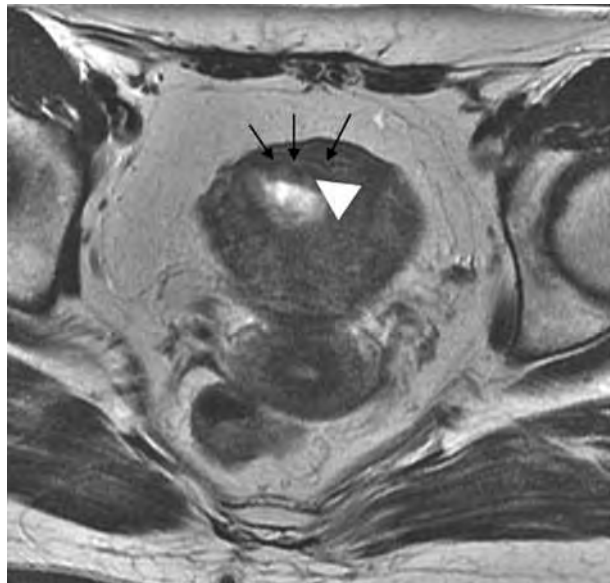


Fig. 3. Stage IB endometrial cancer in a 54-year-old woman. The axial T2-weighted MR image shows a slightly hyperintense mass (arrowhead) with disruption of the junctional zone (arrows).

Table 2  
Myometrium invasion on MRI compared with histological finding ( $n = 66$ ).

Histology	MRI imaging finding			
	<50% myometrium invasion		> 50% invasion myometrium	
<50% invasion	premenopause	postmenopause	premenopause	postmenopause
	19	10	2	8
>50% invasion	premenopause	postmenopause	premenopause	postmenopause
	2	0	12	13

Table 3  
MRI in preoperative evaluation for cancer in detecting deep myometrium invasion.

	Sensitivity	Specificity	accuracy	PPV	NPV	Kappa	P value
Premenopausal women	85.71% (n = 12/14)	90.47% (n = 19/21)	88.57% (n = 31/35)	85.71% (n = 12/14)	90.47% (n = 19/21)	0.76 (Substantial)	<0.0001
Postmenopausal women	100% (n = 13/13)	55.55% (n = 10/18)	74.19% (n = 23/31)	61.9% (n = 13/21)	100% (n = 10/10)	0.51 (moderate)	0.001
Total	92.59% (n = 25/27)	74.35% (n = 29/39)	81.81% (n = 54/66)	71.42% (n = 25/35)	93.54% (n = 21/31)	0.64 (Substantial)	<0.0001

imaging showed sensitivity, specificity, PPV, and NPV results of 87%, 91%, 87%, and 91%, respectively, for the identification of deep myometrium invasion [8]. Hwang et al [9] reviewed all studies focusing on MRI for preoperative evaluation of endometrial cancer and detection of deep myometrium invasion. The sensitivity of MRI for deep myometrium invasion was low (50–84%), whereas the specificity was high (50–100%).

In our study, the overall results and those for premenopausal women were consistent with previous studies. However, for the postmenopausal group, the sensitivity (100%) was better than the specificity (55.56%). The PPV was markedly higher in the premenopausal women than in the postmenopausal women (85.7% vs. 61.9%). This divergence may be because of the extreme physiological thinning of the myometrium in postmenopausal women, which can lead to the overestimation of the extent of myometrium invasion.

As metastasis to the pelvic lymph node depends on tumor invasion of the myometrium, the decision to perform a pelvic lymphadenectomy may be influenced by the MRI results. However, MRI is limited in its ability to detect deep myometrial invasion. The evaluation of an intraoperative frozen section provides the tumor histology type, grade, and extent of the myometrium invasion. Sanjuan et al [10] reported that the combination of preoperative biopsy and intraoperative frozen section is the best way to decide whether an invasive lesion that requires a pelvic lymphadenectomy is present.

The mainstay of endometrial cancer treatment based on the 2009 FIGO guidelines is surgical exploration with a total abdominal hysterectomy and BSO. Nodal dissection is advocated if a high risk of nodal metastases is suspected. The alternative of laparoscopic management has given rise to considerable debates in the past [11,12]. Recently, several clinical trails and retrospective studies have demonstrated the safety, effectiveness, and short-term advantage of laparoscopic staging surgery over laparotomy. Walker et al and Ju et al reported that there were no differences between the laparoscopic and laparotomic routines in the overall, progression-free, and cancer-related survival [13,14].

Another exception to standard management is the omission of a BSO in young women with endometrial cancer, preferably in women with early stage, low-grade disease [15]. This strategy offers the potential for future oocyte retrieval as a family-building option and avoids the adverse consequences of estrogen deprivation. Recently, Wright et al analyzed the safety of ovarian preservation in premenopausal women with

Stage I endometrial cancer. In their analysis, ovarian preservation in premenopausal women with early stage disease appeared to be safe and was not associated with an increase in cancer-related mortality [16].

A preoperative MRI contributes to accurate staging of endometrial cancer to allow planning for the scale of the surgery, as well as preoperative counseling. Although MRI has limited clinical benefit, it has the advantage of making the information available before surgery, especially for young women with early-stage cancer. The pretreatment information about myometrium invasion provides the opportunity for small-scale surgery for premenopausal women. However, for postmenopausal patients the standard surgical procedure is indicated even if the level of myometrium invasion is low.

## References

- [1] Lee TS, Kim JW, Kim DY, Kim YT, Lee KH, Kim BG. Necessity of radical hysterectomy for endometrial cancer patients with cervical invasion. *J Korean Med Sci* 2010;25:552–6.
- [2] Zivanovic O, Carter J, Kauff ND, Barakat RR. A review of the challenges faced in the conservative treatment of young women with endometrial carcinoma and risk of ovarian cancer. *Gynecol Oncol* 2009;115:504–9.
- [3] Hidaka T, Nakashima A, Shima T, Hasegawa T, Saito S. Systemic lymphadenectomy cannot be recommended for low-risk corpus cancer. *Obstet Gynecol Int* 2010;2010:490219.
- [4] Creasman W. Revised FIGO staging for carcinoma of the endometrium. *Int J Gynaecol Obstet* 2009;105:109.
- [5] Mariani A, Dowdy SC, Podratz KC. New surgical staging of endometrial cancer: 20 years later. *Int J Gynaecol Obstet* 2009;105:110–1.
- [6] Petru E, Luck HJ, Stuart G, Gaffney D, Millan D, Vergote I. Gynecologic cancer intergroup (GCIG) proposals for changes of the current FIGO staging system. *Eur J Obstet Gynecol Reprod Biol* 2009;143:69–74.
- [7] Harry Vanessa N, Deans Heather, Ramage Emma. Magnetic resonance imaging in gynecological oncology. *Int J Gynecol Cancer* 2009;19:186–93.
- [8] Manfredi R, Mirk P, Maresca G. Local-regional staging of endometrial carcinoma: role of MR imaging in surgical planning. *Radiology* 2004;231:372–8.
- [9] Jong Ha Hwang, Nak Woo LEE, Kyu Wan LEE. Magnetic resonance imaging for assessment of deep endometrial invasion for patients with endometrial carcinoma. *Aust N Z J Obstet Gynaecol* 2009;49:537–41.
- [10] Sanjuan A, Cobo T, Pahisa J. Preoperative and intraoperative assessment of myometrial invasion and histologic grade in endometrial cancer: role of magnetic resonance imaging and frozen section. *Int J Gynecol Cancer* 2006;16:385–90.
- [11] Hahn HS, Kim HJ, Yoon SG, Kim WC, Choi HJ, Kim HS. Laparoscopy-assisted vaginal versus abdominal hysterectomy in endometrial cancer. *Int J Gynecol Cancer* 2010;20:102–9.

- [12] Santi A, Kuhn A, Gyr T, Eberhard M, Johann S, Gunthert AR. Laparoscopy or laparotomy? A comparison of 240 patients with early-stage endometrial cancer. *Surg Endosc* 2010;24:939–43.
- [13] Wright JD, Buck AM, Shah M, Burke WM, Schiff PB, Herzog TJ. Safety of ovarian preservation in premenopausal women with endometrial cancer. *J Clin Oncol* 2009;27:1214–9.
- [14] Walker JL, Piedmonte MR, Spirtos NM, Eisenkop SM, Schlaerth JB, Mannel RS. Laparoscopy compared with laparotomy for comprehensive surgical staging of uterine cancer: Gynecologic Oncology Group Study LAP2. *J Clin Oncol* 2009;27:5331–6.
- [15] Lee TS, Jung JY, Kim JW, Park NH, Song YS, Kang SB, et al. Feasibility of ovarian preservation in patients with early stage endometrial carcinoma. *Gynecol Oncol* 2007;104:52–7.
- [16] Ju W, Myung SK, Kim Y, Choi HJ, Kim SC. Comparison of laparoscopy and laparotomy for management of endometrial carcinoma: a meta-analysis. *Int J Gynecol Cancer* 2009;19:400–6.