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Original Article

Magnetic resonance imaging for detection of depth of myometrial invasion and cervical invasion in patients with endometrial carcinoma

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Abstract: Aims: The aim of this study was to evaluate clinical significance of depth of myometrial invasion and cervical invasion by magnetic resonance imaging (MRI) in patients with endometrial carcinoma. Methods: Between September 2011 and October 2014 on 98 patients who were diagnosed with and treated for endometrial carcinoma at Subei People's Hospital in China included in this study. Main outcome measure was the correlation between the depth of myometrial invasion and cervical invasion by preoperative MRI, transvaginal sonography, hysteroscopy with directed biopsy study and the subsequent histopathological findings following examination of the hysterectomy specimen. Results: The mean age was 54.6 years old and the most common histological subtype was the endometrioid type of endometrial adenocarcinoma (87.8%). In the evaluation of deep myometrial invasion (>50%), sensitivity, specificity, positive and negative predictive value and positive and negative likelihood ratios of MRI were 70.00%, 94.87%, 77.78%, 92.50%, 13.65, 0.316, respectively. For cervical invasion, these values were 72.73%, 98.85%, 88.89%, 96.63%, 63.27, 0.30, respectively. Conclusion: MRI is the superior diagnostic method to detect the myometrial invasion and cervical invasion.

Keywords: Endometrial carcinoma, MRI, myometrial invasion, cervical invasion

Introduction

Endometrial carcinoma is the most common gynaecological malignancy in the developed world, predominantly affecting postmenopausal women. And it is also one of the most common malignancies of the female genital tract in China [1]. The prognosis of endometrial carcinoma depends on a number of factors, including stage, depth of myometrial invasion, cervical invasion, lymphovascular invasion, histologic grade and many other factors [2]. According to the International Federation of Gynecology and Obstetrics (FIGO) in 2009 [3], myometrial invasion was classified into two categories: IA, no or less than half myometrial invasion; IB, invasion equal to or more than half of the myometrium. So the depth of myometrial invasion is probably the most major morphologic prognostic factor. According to FIGO in 2009 [3], cervical invasion was classified into stage II: tumor invades cervical stroma, but does not extend beyond the uterus. Women with endometrial cancer limited to the endometrium have a high 5-year survival rate (83%) [4]. However, cervical invasion by endometrial cancer is associated with a decreased 5-year survival compared with endometrial cancer confined to the body of the uterus [5].

Myometrial invasion and cervical invasion are the most important factors related to the therapy and prognosis of endometrial carcinoma. Although transvaginal sonography has been proposed as the fist-line diagnostic tool for evaluating endometrial thickness and hysteroscopy with directed biopsy is much sensitive in disclosing all types of uterine lesion, owing to excellent soft tissue contrast resolution and multiplanar capability, MRI is considered the most accurate imaging technique for preoperative assessment of endometrial cancer [6-8]. Compared with transvaginal sonography (TVS) and hysteroscopy with directed biopsy, this study investigated the accuracy and clinical application of MRI in the preoperative assess-

Table 1. Characteristics of women included in study

Characteristics	
Number of women	98
Mean (rang) age, y	54.6 (31-74)
<45 years old (%)	12 (12.2)
Pre-menopause (%)	24 (24.5)
Tumor grade* (%)	
G1	58 (59.2)
G2	24 (24.5)
G3	6 (6.1)
Not graded	10 (55.6)
Tumor type (%)	
Endometrioid	86 (87.8)
Serous	0
Clear cell	2 (2.0)
Undifferentiated adenocarcinoma (others)	10 (10.2)
2009 FIGO stage (%)	
IA	50 (51.0)
IB	26 (26.5)
II	14 (14.3)
IIIA	6 (6.1)
IIIB	0
IIIC	2 (2.0)
IVA	0
IVB	0

*Based on 2009 FIGO grading.

ment of women with biopsy-proven endometrial cancer.

Materials and methods

Patients

Our study was performed between September 2011 and October 2014 on 98 patients, identified by a retrospective review of the records, who were diagnosed with and treated for endometrial carcinoma at Subei People's Hospital in China. Women in whom complete data were not available, as well as those who did not have an MRI and/or who did not undergo hysterectomy, were excluded.

All patients underwent staging surgery including total hysterectomy and bilateral salpingo-oophorectomy. For suspicious cases, lymphadenectomy was performed. If the cervix was involved, a radical hysterectomy would be done. Compare with transvaginal sonography (TVS), hysteroscopy with directed biopsy (H+B) and MRI, we can know which one of them plays a dominant role in detecting the depth of myometrial invasion and cervical invasion. Patient characteristics are presented in **Table 1**.

MRI

MRI was acquired with 3.0 T system and phased-array pelvic coil. Pelvic MRI examination was composed of T2-weighted images, T1-weighed images and dynamic contrastenhanced images at 3.0T. Based on previously published criteria [9], superficial (<50%) myometrial invasion was detected by disruption of the junctional zone and deep (≥50%) myometrial invasion was detected by a preserved stripe enhancing outer myometrial wall. Absent invasion was diagnosed when a clear and uninterrupted junctional. Cervical invasion was diagnosed when disruption of the low-signal intensity inner cervical stroma appearing in T2-weighted images or disruption of the cervical epithelium enhancement appearing in dynamic contrastenhanced images.

Following blinded interpretation of the MRI, the pathologic findings were reviewed together with MRI and the pathologic finding was treated as the gold standard.

TVS and H+B

Among 98 patients, 62 patients had a transvaginal sonography (TVS), 48 patients had a hysteroscopy with directed biopsy (H+B) and 50 patients had a dilatation and curettage. The records were reported by specialists, respectively.

Statistical analysis

Statistical analysis was performed by SPSS for windows 16.0. The sensitivity, specificity and positive predictive value (PPV) and negative predictive value (NPV) were calculated. The comparisons were made between MRI and transvaginal sonography, MRI and hysteroscopy with directed biopsy, to identify the accuracy in detecting the depth of myometrial invasion and cervical invasion using a Chi-square test.

Result

Among 98 patients that all had an MRI included in this study, the mean age was 54.6 years

Table 2. Performance of MRI and TVS in predicting myometrial invasion when performed individually

	Pathology: myometrial invasion				Sen, (%)	Spe, (%)	PPV (%)	NPV (%)	PLR	NLR
	None	<50%	≥50%	Total						
MRI										
None	10	14	2	26	71.43	80.95	38.46	94.44	3.75	0.35
<50%	4	46	4	54	71.88	76.47	85.19	59.09	3.05	0.22
≥50%	0	4	14	18	70.00	94.87	77.78	92.50	13.65	0.32
Total	14	64	20	98						
Kappa value					0.494					
TVS										
None	4	9	0	13	66.67	83.93	30.77	95.92	4.15	0.40
<50%	2	22	3	27	66.67	82.76	81.48	68.57	3.87	0.40
≥50%	0	2	20	22	86.96	94.87	90.91	92.50	16.96	0.14
Total	6	33	23	62						
Kappa value					0.452					

Abbreviations: NLR; negative likelihood ratio, NPV; negative predictive value, PLR; positive likelihood ratio, PPV; positive predictive value, Sen; sensitivity, Spe; specificity.

(range 31-74 years) and 24 (24.5%) were premenopausal. The more characteristics of patients are presented in **Table 1**. The most common histological subtype was the endometrioid type detected in 87.8% (86) of the patients and the most common tumor grade was well differentiated type (G1) 59.2% (58). A total of 62 had a transvaginal sonography (TVS) and 48 patients had a hysteroscopy with directed biopsy (H+B).

Part of data are presented in **Table 2**. In the surgicopathological report, in 65.3% (64/98), the depth of myometrial invasion was less than 50% and in 20.4% (20/98), there was an equal or greater than 50% involvement and 14 patients (14.29%) had no involvement of the myometrium. 14 out of 26 patients (53.85%) who did not have any myometrial invasion in the MRI report, had lower than 50% myometrial involvement in the final pathological findings. 4 out of 54 patients (7.41%) with less than 50% myometrial involvement in MRI ultimately had more than 50% myometrial involvement. In the evaluation of the deep myometrial invasion (more than 50%), the sensitivity, specificity, positive and negative predictive values and positive and negative likelihood ratios of MRI were 70.00%, 94.87%, 77.78%, 92.50%, 13.65, 0.316, respectively. 14 out of 26 patients (53.85%) who did not have any myometrial invasion in the TVS report, had lower than 50% myometrial invasion in the final pathological findings. Four out of 54 patients (7.41%) with less than 50% myometrial invasion in TVS ultimately had more than 50% myometrial invasion. **Table 2** shows the correlation of myometrial involvement in MRI, TVS and pathology.

According to the correlation of cervical invasion in MRI, TVS, hysteroscopy with directed biopsy (H+B) and the final pathology report, 86 out of 89 patients (96.63%) without cervical involvement in MRI did not have any cervical invasion in the surgicopthological report. 56 out of 57 patients (98.25%) without cervical involvement in TVS did not have any cervical invasion in the surgicopthological report. All patients without cervical involvement in H+B did not have any cervical invasion in the surgicopthological report. **Table 3** shows the correlation of cervical invasion in MRI, TVS, H+B and pathology.

Discussion

The stage depth of myometrial invasion, cervical invasion, lymphovascular invasion, histologic grade affect the prognosis of endometrial carcinoma. Myometrial invasion and cervical invasion are the most important factors related to the therapy and prognosis of endometrial carcinoma. Based on 2009 FIGO grading, the majority of patients included in our study were in the early stage (51.0% for the stage IA and 26.5% for the stage IB). The sensitivity, specificity, PPV and NPV of MRI in discriminating deep myometrial invasion (≥50%) have been shown in several studies [9-11]. McComiskey MH, et al. found the sensitivity, specificity, PPV, NPV,

Table 3. Performance of MRI, TVS and hysteroscopy with directed biopsy (H+B) in predicting cervical invasion when performed individually

	Pathology: cervical invasion			Sen, (%)	Spe, (%)	PPV (%)	NPV (%)	PLR	NLR
	Yes	No	Total						
MRI				72.73	98.85	88.89	96.63	63.27	0.30
Yes	8	1	9						
No	3	86	89						
Total	11	87	98						
TVS				80.00	98.25	80.00	98.25	45.6	0.20
Yes	4	1	5						
No	1	56	57						
Total	5	57	62						
H+B				100	97.67	83.33	100	43	0
Yes	5	1	6						
No	0	42	42						
Total	5	43	48						

Abbreviations: NLR; negative likelihood ratio, NPV; negative predictive value, PLR; positive likelihood ratio, PPV; positive predictive value, Sen; sensitivity, Spe; specificity.

PLR and NLR of MRI were 73%, 83%, 63%, 89%, 4.35, 0.33, respectively [10]. Similar to other studies, in our study, the data were similar to the above, they were 71.43%, 80.95%, 38.46%, 94.44%, 3.75, 0.35, respectively. Hans Nagar et al. reported that the sensitivity, specificity, PPV, NPV, PLR and NLR of MRI in discriminating cervical invasion were 72%, 93.2%, 89.8%, 80.2%, 10.7, 0.3, respectively [5]. A combined sensitivity of 72.73%, specificity of 98.85%, PPV of 88.89%, NPV of 96.63%, PLR of 63.27 and NLR of 0.30 to detect cervical invasion in our study suggest that MRI is an accurate method in endometrial cancer.

Abnormal uterine bleeding was the most frequent symptom of endometrial carcinoma [12]. We therefore consider TVS as the first step in any woman presenting with abnormal uterine bleeding or endocervical curettage, someone even need hysteroscopy with directed biopsy. TVS is simple available and has reasonable accuracy in predicting cervical and myometrial invasion from endometrial cancer [12]. From **Table 2**, we know that the sensitivity of MRI was higher than that of TVS when the cancer limited to the endometrium or superficial myometrial invasion, but it was lower of MRI than that of TVS when the cancer infiltrates to the deep myometrial invasion. TVS is operator dependent which should be the main reason. From **Table 3**, in detecting the cervical invasion, the sensitivity of MRI was lower than that of TVS, but the difference was not significant (P=0.807). Hysteroscopy with directed biopsy had a evidently higher sensitivity than MRI and TVS had. Due to the junction between the lower uterine segment and the endocervix is not clearly defined [13], MRI and TVS are not the appropriate tools for the description of cervical invasion. However, hysteroscopy is effective in collecting specimens under visual control from anywhere in the uterine cavity [7]. It is a pity that hysteroscopy cannot detect the tumor infiltrating to the cervical stroma, but only the cervical endometrium. Although someones [14] found TVS has high specificity and accuracy in predicting myometrial invasion and cervical invasion in patients with endometrial cancer, TVS makes patients uncomfortable. And Fotopoulou et al. reported that TVS may reliably be utilized for the preoperative assessment of tumor size, presence of ascites and adnexal metastases, but less reliable for the detection of cervical invasion [15].

In summary, this large prospective implementation study shows that MRI is the superior diagnostic method to detect the myometrial invasion and cervical invasion. From our study, MRI has a high sensitivity (71.43%) in detecting endometrial cancer which limited to the endometrium. In other words, MRI can diagnose endometrial cancer in the early stage and may be a useful tool to guide the surgical approach, avoiding overtreating low-risk.

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Disclosure of conflict of interest

None.

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