



Utility of intravaginal ultrasound gel for local staging of cervical carcinoma on MRI[☆]



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ABSTRACT

Purpose: The aim of this study is to evaluate the utility of intravaginal ultrasound gel for the staging of cervical carcinoma on magnetic resonance imaging (MRI) and to confirm the results with pathological staging.

Methods: Nine patients were included in the study. T2-weighted images were compared without and with vaginal gel (VG).

Results: Five patients were evaluated as overstaged on MRI without VG. After VG, the results were compatible with the pathological stages in all patients.

Conclusions: We suggest that this technique is easy, well tolerated, and effective, and it increases the accuracy rate of MRI staging in early cervical cancer.

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1. Introduction

Cervical cancer is the third most common malignancy affecting the female genital tract. Magnetic resonance imaging (MRI) is the basic imaging method used in the local staging of the tumor [1]. MRI has facilitated determining the size and parametrial invasion level of carcinoma. The tumor compression on surrounding structures can be supposed as the invasion on MRI. Therefore, MRI may overestimate cervical cancer staging [2].

Various solid and liquid materials have been tested for use in visualizing the internal contours of the vaginal wall and fornices to reduce the false negativity of MRI [1–4]. Solid materials may be more uncomfortable than liquid ones, and they can cause susceptibility to artifacts [1]. Water-based materials have advantages, such as filling spaces without disturbing the anatomical structures and hyperintense signal on T2-weighted (T2W) sequences [2,4]. In addition, ultrasound gel, which is more viscous, also causes less backflow during intravaginal application. Although, intravaginal gel is already commonly used in pelvic protocols in many centers, its use and potential benefits have not been scientifically tested. In the literature, there is only one study that uses ultrasound gel in MRI for genital-tract cancers [1]. There are no studies that

evaluate the utility of MRI with intravaginal ultrasound gel in cervical carcinoma and confirm the results via pathological staging.

The aim of this study is to evaluate the efficiency of intravaginal ultrasound gel for the local staging of cervical carcinoma on MRI and to confirm the results with pathological staging.

2. Material and methods

2.1. Study population

Twenty patients who were confirmed to have cervical cancer via biopsy were enrolled in our study. This prospective study was approved by the local ethics committee. Informed consent forms were obtained from the participants.

After clinical and radiological evaluation, 11 patients who had high stages and chemoradiotherapy were excluded from our study due to not having pathology results. Nine patients (from 34 to 58 years of age; mean 47.5) who had pathological staging were included in our study.

2.2. MRI technique

All 20 patients underwent pelvic MRI. MRI images were obtained with a 1.5-T MR imaging system (Philips Achieva; Philips Medical Systems, Best, Netherlands) with a phased array coil. T2W turbo spin echo images were obtained in the sagittal and oblique axial planes. Oblique axial sections were obtained as perpendicular to the long axis

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of the cervix. The scan parameters for the T2W sequences were repetition time/echo time 4889/90, with an echo train of length 22, matrix of 192×259, section thickness of 5 mm for the axial and sagittal planes with a 1-mm gap, and a field of view of almost 250 mm.

2.3. Vaginal opacification

After the standard pelvic MRI was taken, all patients underwent MRI with ultrasound gel for vaginal opacification. Initially, approximately 50 ml of ultrasound gel was slowly infused into the vagina through a Foley catheter by the gynecologist, without changing the position of the patient. Later, the infusion was stopped, and when the gel was observed draining to the perineum, the MRI sequences were taken.

2.4. Image evaluation

Two radiologists interpreted the MRI sequences in the digital imaging and communication in medicine viewer software OsiriX (Pixmeo Labs, Geneva, Switzerland). All images were evaluated in two sessions. Initially, T2W images without vaginal gel (VG) and then T2W images with VG were evaluated in the axial and sagittal planes. The MRI was analyzed with respect to the following: (a) tumor dimension; (b) parametrial invasion; (c) involvement of the vaginal wall and fornices; and (d) pelvic wall, urinary bladder, and rectum. The tumor dimension was enrolled by measuring the largest diameter of the mass in the sagittal plane in millimeters.

The staging of the cervical cancer was evaluated according to the classification of the International Federation of Gynecology and Obstetrics (FIGO) system, which was updated in 2009 (Table 1) [5].

3. Results

In our study, we evaluated pelvic MRI findings of nine patients with cervical cancer who had surgical staging. The staging with MRI was compared with the pathological findings.

Table 1
Cervical carcinoma: FIGO staging with corresponding MRI findings.

Stage I	Carcinoma is strictly confined to cervix (extension to the corpus would be disregarded)
IA	Invasive carcinoma diagnosed by microscopy with the deepest invasion ≤5 mm and the largest extension ≥7 mm
IA1	Stromal invasion of ≤3 mm in depth and extension of ≤7 mm
IA2	Stromal invasion between 3 and 5 mm and extension of not more than 7 mm
IB	Clinically visible lesions limited to cervix or preclinical cancer greater than stage IA
IB1	Clinically visible lesion ≤4 cm in the greatest dimension
IB2	Clinically visible lesion >4 cm in the greatest dimension
Stage II	Carcinoma invades beyond the uterus but not to the pelvic wall or to the lower-third of the vagina
IIA	Without parametrial invasion
IIA1	Clinically visible lesion ≤4 cm in the greatest dimension
IIA2	Clinically visible lesion >4 cm in the greatest dimension
IIB	With obvious parametrial invasion
Stage III	Tumor extends to the pelvic wall and/or involves lower third of the vagina and/or causes hydronephrosis or nonfunctioning kidney
IIIA	Tumor involves lower third of the vagina with no extension to the pelvic wall
IIIB	Extension to the pelvic wall and/or hydronephrosis or nonfunctioning kidney
Stage IV	Carcinoma has extended beyond the true pelvis or has involved (biopsy proven) the mucosa of bladder or rectum. A bulbous edema does not permit a case to be allotted to stage IV
IVA	Spread of cancer to adjacent organs
IVB	Spread to distant organs

Ultrasound gel demonstrated markedly high signal intensity on T2W images. The largest measurement of the tumor ranged from a minimum of 6 mm to a maximum of 40 mm. There was some air bubble accumulation within the upper vagina in five patients. During VG application, discomfort was not observed in patients.

Before VG, on MRI, the tumor was confined to the cervix in four patients (stage IB1). The involvement of the bilateral fornices was observed in two patients, and the involvement of the vaginal wall (Fig. 1a) was seen in one patient (stage IIA1). Additionally, the invasion of the parametrium was suspected in two patients (stage IIB) (Fig. 2a). After VG, on MRI, the tumors were found to be limited to the cervix in all patients, and there was no fornix involvement (Fig. 1b) or parametrial invasion (Fig. 2b).

Before VG, four IB1, three IIA1, and two IIB stage tumors were observed on MRI. However, after VG, there were stage IB1 tumors in all patients. In the pathological assessment, all patients had stage IB1 tumors, as well. The pathological stages and MRI staging with and without VG are summarized in Table 2.

When we compared the pre- and post-VG-examination MRI stages of four patients, they were identical. Nevertheless, there was incompatibility in the results of five patients.

When MRI images without VG were compared with pathological findings, four patients (44.4%) were correctly staged, but five patients (55.6%) were evaluated as overstaged on MRI without VG. However, the stages on MRI with VG were completely compatible with the pathological stages in all nine patients (100%) (Fig. 3).

4. Discussion

In the literature, there are a few publications about intravaginal contrast-enhanced MRI for staging female pelvic cancers [1,2,4]. To our knowledge, this is the first study that evaluates the utility of intravaginal ultrasound gel for the local staging of cervical carcinoma on MRI. Our results showed that the accuracy rate of MRI in the local staging of cervical cancer increases after vaginal opacification with ultrasound gel.

Determining patients' stages has great importance in deciding treatment strategies [6,7]. MRI plays a critical role in the prediction of staging. T2W images guide the identification of the primary tumor, which is usually seen as hyperintense in this sequence [7,8]. In T2W images, an intact hypointense stromal ring has a high negative predictive value for parametrial involvement [9]. The accuracy rate of parametrial involvement on MRI is 67%–90% [4,10]. The presence of parametrial involvement on MRI is important in deciding the operability of the patients with cervical carcinoma. MRI may overstage tumors due to edema, inflammation, or compression [11]. In our study, false-positive parametrial invasion was detected in two patients on MRI without VG. However, after the application of VG, the tumors were found to be limited to the cervix, and in this way, the MRI results were completely consistent with the pathological findings.

The standard scanning techniques are inadequate to differentiate a tumor from surrounding edema and vaginal invasion [12]. In our study, there were three false positives due to upper vaginal invasion on MRI without VG. After vaginal collapse and tumor compression were eliminated by ultrasound gel, the vaginal wall and fornices were seen as normal on MRI. Therefore, this method facilitates the correct interpretation of the images for radiologists.

Various solid and liquid materials have been tested for use in ensuring vaginal distension [1–4]. Solid materials such as tampons can cause the deformation of the surrounding structures and air artifacts. Also, they cannot fill all the anatomic spaces due to their stiffness [3]. Thus, water-based composite substances are more useful than solid ones because they better fill the vagina, are less disturbing for patients, and provide higher intensity on T2W sequences [1].

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