European Journal of Radiology xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Magnetic resonance imaging of cervical carcinoma using an endorectal surface coil

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ARTICLE INFO

Article history:
Received 18 August 2013
Received in revised form 6 February 2014
Accepted 9 February 2014

Keywords:
Cervical cancer
MRI with endorectal surface coil
FIGO classification

ABSTRACT

Introduction: The objective of this trial is to investigate the diagnostic value of magnetic resonance imaging (MRI) with an endorectal surface coil for precise local staging of patients with histologically proven cervical cancer by comparing the radiological, clinical, and histological results.
Materials and methods: Women with cervical cancer were recruited for this trial between February 2007, and September 2010. All the patients were clinically staged according to the FIGO classification and underwent radiological staging by MRI that employed an endorectal surface coil. The staging results after surgery were compared to histopathology in all the operable patients.
Results: A total of 74 consecutive patients were included in the trial. Forty-four (59.5%) patients underwent primary surgery, whereas 30 (40.5%) patients were inoperable according to FIGO and underwent primary radiochemotherapy. The mean age of the patients was 50.6 years. In 11 out of the 44 patients concordant staging results were obtained by all three staging modalities. Thirty-two of the 44 patients were concordantly staged by FIGO and histopathological examination, while only 16 were concordantly staged by eMRI and histopathological examination. eMRI overstaged tumors in 14 cases and understaged them in 7 cases.
Conclusions: eMRI is applicable in patients with cervical cancer, yet of no benefit than staging with FIGO or standard pelvic MRI. The most precise preoperative staging procedure still appears to be the clinical examination.

1. Introduction

Cervical carcinoma is a frequent gynecological malignancy. According to reports from the National Cancer Institute, it is estimated that about 12,170 women will be diagnosed with and 4220 women will die of cancer of the cervix uteri in 2012 in the United States of America. Based on results from 2005–2009, the median age at diagnosis for cancer of the cervix uteri is 48 years of age. The age-adjusted incidence is considered to be 8.1 per 100,000 women per year [1].

Reliable and accurate staging is essential to permit adequate therapy planning prior to primary therapy. Yet several essential parameters for treatment planning can only be estimated clinically and not always answered in detail (i.e., parametrial or pelvic side wall invasion, lymph node status, or size of the endocervical tumor). The most common clinical staging system was suggested by the FIGO (International Federation of Gynecology and Obstetrics) classification [1–4], which is closely related to general treatment strategies such as surgical intervention or radiochemotherapy in an inoperable situation.

Accurate pretherapeutic staging of this tumor is important to determine whether surgical intervention is possible or not. In most institutions, patients assigned to a FIGO classification from Ia1 to IIa are treated surgically, whereas patients with FIGO IIb predominantly undergo primary radiochemotherapy [5]. In more advanced

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http://dx.doi.org/10.1016/j.ejrad.2014.02.011
0720-048X/

stages of cervical cancer, primary radiochemotherapy appears to be the treatment of choice, although pelvic exenteration may be considered in some stage IV situations [6–8].

In order to achieve accurate staging, a precise imaging modality such as magnetic resonance imaging (MRI) has been suggested to be useful. The superior contrast and high resolution of MRI and its multiplanar capability has been shown to make MRI valuable for evaluating local tumor extent, any invasion of adjacent structures, and lymph node status. It is regarded as the most reliable and reproducible modality for conducting a pretherapeutic tumor investigation because its staging ability is better than that of the clinical FIGO staging system [9–11]. In order to obtain even more precise information about local tumor spread, an endorectal surface coil (ESC) can be placed into the rectum behind the cervix. In several studies MRI using an integrated endorectal coil (eMRI) has shown improved results over standard MRIs using surface coils since eMRI has a higher resolution and a better signal-to-noise ratio due to a decreased field of view [3,5,10,12–14].

In this prospective study all the patients with histologically proven cancer of the cervix were additionally examined using eMRI. The eMRI results were then compared to the clinical and histopathological results, the latter if primary surgery had been conducted. Patients who underwent primary radiochemotherapy were evaluated separately. This trial investigates the diagnostic value of eMRI for precisely staging cervical cancer.

2. Materials and methods

The present study was designed as a prospective, controlled clinical trial conducted in accordance with the Declaration of Helsinki 2008. The study proposal was approved by the local ethics committee. All women recruited for this trial gave their written informed consent. Each patient with histologically proven cervical cancer after local biopsy underwent pretreatment staging with eMRI. An experienced gynecologic oncologist with 15 years of practice assigned a clinical stage for each patient according to FIGO. In an interdisciplinary tumor conference the subsequent therapy procedures were discussed for each patient. Patients then either underwent radical hysterectomy with pelvic lymph node resection, which were subsequently histopathologically staged, or they underwent primary radiochemotherapy (in cases of tumors that were definitely clinically inoperable or in primarily uncertain ones in which intraoperative staging is done on patients during staging surgery). In patients considered to be inoperable, histopathological staging was not applicable, and the eMRI results are merely compared to the FIGO staging. Primary surgery was performed in the Department of Gynecology and Obstetrics within one week of eMRI.

The patients were asked not to empty their bladder for 1 h prior to eMRI to ensure moderate filling. In order to reduce bowel movements 20 mg butylscopolamine bromide (Buscopan®, Boehringer Ingelheim Pharma GmbH & Co. KG, Ingelheim, Germany) per 60 kg body weight was administered intravenously if no contraindication (cardiac arrhythmia or glaucoma) was noted, as recommended by Kinkel et al. [7] To improve demarcation of the anterior and posterior vaginal wall and the cervix, 20 mL sterile ultrasonic gel (Endosgel®, Farco-Pharma GmbH, Cologne, Germany) was inserted into the vagina using a syringe and a small catheter.

MRI was performed using a 1.5 T scanner (Magnetom Symphony, Siemens, Erlangen, Germany). After digital rectal palpation, an ESC for the cervix (MRInnervue®, MEDRAD, Volkach, Germany) was cautiously placed into the rectum if no contraindication was noted (i.e., latex allergy, chronic intestinal disease, high-grade hemorrhoids, or rectal surgery within the previous 8 weeks). Depending on the scanner employed, the ESC was combined with a body array coil, which had the advantage of combined high local spatial resolution and the option of visualizing retroperitoneal lymph nodes in one examination [15,16]. The examination was performed with patients lying in a supine position, their knees elevated on a special pillow to reduce any discomfort possibly caused by the ESC. Correct placement of the coil was confirmed using an initial overview true fast imaging with steady-state precession (TrueFISP) sequence, and the ESC was relocated if necessary [17]. A predefined protocol of sequences was performed in all patients, including high-resolution T2-weighted images and contrast-enhanced T1-weighted images in the sagittal and transversal planes. The transversal plane was performed in oblique technique, parallel to the short axis of the cervix [18]. To evaluate the lymph node status of the pelvis, transverse coverage was performed from the inguinal region up to the lower renal pole. eMRI lasted a total of 30 min with a real scan time of 16 min. The application of the ESC took on average 5 min per patient.

All MR images were interpreted by two radiologists in consensus reading, both of whom are experienced in the field of urogenital imaging (a junior radiologist with 8 and senior radiologist with 17 years of practice, respectively). Both radiologists were informed about the diagnosis of cervical cancer, but were unaware of the detailed histological information or the FIGO stage. On T2-weighted (T2w) images, cervical cancer is defined as a moderate hyperintense lesion [18]; on contrast-enhanced T1-weighted (T1w) images, cervical cancer is more hypointense than cervical stromal tissue [19]. After the tumor was detected, its extent was measured in the sagittal and oblique transverse planes. The MR image evaluation included tumor detection, sizing of the tumor's greatest diameter, detection of any tumor invasion of adjacent structures, and detection of pathological or abnormal lymph nodes whose short diameter is greater than 1 cm.

All the samples were analyzed by the same experienced pathologist informed about the clinical FIGO staging but unaware of eMRI results. Histopathological analysis of the cervical cancer included determination of tumor localization and size, any invasion of adjacent tissue, any lymph node metastases, the histological tumor type, lymph vessel invasion and hemangiosis, such as tumor grading.

All the data regarding the clinical examination (CE), eMRI staging, and the histopathological results were gathered and compiled in a Microsoft Excel table. The data were analyzed using methods of descriptive statistics and SPSS for Windows (Version 18.0, SPSS Inc., USA). The median age was calculated. The histopathological results were considered the gold standard.

3. Results

From February 2007, until September 2010, a total of 74 consecutive patients diagnosed with cervical cancer were recruited into this trial. Every woman was staged clinically according to the FIGO classification and by eMRI. Forty-four (59.5%) patients underwent primary surgery, and 30 (40.5%) were considered inoperable and given primary radiochemotherapy. The mean age of the patients was 51.6 years (standard derivation (SD) 12.26), with the youngest being 26 and the oldest 74. The 44 patients who underwent primary surgery were treated as described by Piver and Rutledge in 1974 [8,20].

In the following description of the study results, the number of 44 women is considered 100% (i.e., for patients who underwent primary surgery). In seven (15.9%) patients, eMRI was not able to detect a tumor lesion, which is described in the following tables as not applicable. Histopathological analysis of these seven patients assigned three patients to the pT1a1 stage and four to the pT1b1 stage (Fig. 1). With regard to all 44 patients, 11 were staged

Please cite this article in press as: Brocker KA, et al. Magnetic resonance imaging of cervical carcinoma using an endorectal surface coil. Eur J Radiol (2014), http://dx.doi.org/10.1016/j.ejrad.2014.02.011