Early-stage cervical carcinoma: role of multidetector CT in correlation with histopathologic findings

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Purpose

Invasive cervical carcinoma is the third most common gynecologic malignancy [1]. The prognosis of the disease is based on the stage, tumor dimensions, histologic grade and presence or absence of lymph node metastases [1-6].

There are four stages of the disease as defined by the staging system of the International Federation of Gynecology and Obstetrics (FIGO staging), recently modified (Table 1) [7, 8]. Accurate determination of the stage of cervical carcinoma is essential to guide optimal treatment planning [1-6]. In patients with parametrial invasion (stage IIB or above) and/or lymph node metastases avoidance of surgery and radiation therapy/chemotherapy is preferred [1-6].

CT in the study of primary cervical carcinoma has been mainly used in staging patients with advanced disease and in detecting tumor recurrence [2-4, 9-16]. CT was reported inadequate in the detection of primary neoplasm and staging of early-disease [2-4, 9-16]. Multidetector CT (MDCT) by reducing slice thickness, improved spatial resolution and enabled the creation of multiplanar and 3-dimensional (3D) reconstructed images, of excellent anatomic details, providing satisfactory information both in the detection and staging of gynecologic malignancies [17-22].

The purpose of this retrospective study was to assess the diagnostic performance of multidetector CT on a 16-row CT scanner in preoperative staging of patients with surgical-pathological proven early-stage cervical carcinoma.

Methods and Materials

Study patients

Fourteen-one consecutive women (range age: 28-82 years; mean age: 55 years) with the histologic diagnosis of uterine cervical carcinoma by means of biopsy, were referred for CT of the abdomen. A full clinical and gynecologic history was obtained from all patients and physical examination, complete laboratory data analysis, chest radiography, pelvic examination under anaesthesia, cystoscopic and sigmoidoscopic examination was performed in all cases.

From the study the following patients were excluded: (a) 14 patients with evidence of advanced disease both clinically and radiologically (six patients with stage IIB disease and the presence of pelvic and/or retroperitoneal lymphadenopathy in five cases, one patient with stage IIIA disease and retroperitoneal lymphadenopathy, three patients with stage IVA, one with stage IVB disease, and three cases with stage IIA disease, accompanied by pelvic lymphadenopathy), treated with radiation therapy and/
or chemotherapy; (b) two patients who were poor surgical candidates, also referred for radiation therapy; (c) six patients in whom CT examination was performed after conization (n=5) and after radiation therapy (n=1); and (d) one patient, lost to follow-up.

The study cohort constituted of 18 women (range age: 28-70 years, mean age: 50 years) with surgical-pathological proven early-stage carcinoma of the uterine cervix (radical hysterectomy, with pelvic lymphadenectomy in eight cases). Surgical exploration was performed within four weeks after imaging evaluation, in all patients.

CT technique

All CT examinations were performed on a 16-row CT scanner (Mx8000 IDT, Philips). The CT protocol included scanning of the abdomen, covering the area from the diaphragm to the symphysis pubis, after the i.v. administration of non-ionic iodinated contrast material (120 ml, of 320 mg I/ml, with a flow rate of 3 ml/sec). The scan delay was 70 sec (portal phase). The CT parameters used were the following: detector collimation 16 x 0.75 mm slice thickness 0.8 mm, reconstruction interval 0.5 mm, rotation time 0.5 sec, pitch 1.2, kV 120 and mAs 110. A scout view of the entire abdomen was obtained five minutes after the i.v. administration, for the depiction of the urinary tract (CT-urogram). Patients were asked to drink 1.000 ml of water, 30 minutes prior to the CT examination.

CT data interpretation was performed on a workstation (MxView, Philips), using multiplanar reformatted images in the transverse, sagittal and coronal planes, of 2 mm thickness and 2 mm intervals. Both soft tissue (W: 350 HU, L: 50 HU) and narrow window (W: 250 HU, L: 100 HU) settings were used, to better discriminate tumoral tissue from the normally enhancing cervical and uterine parenchyma. A zoom factor of 1.5 - 2.0 was used for the pelvic region. Three-dimensional (3D) reconstructed images, using volume-rendered algorithms, in the sagittal and coronal planes were also created and used for CT data analysis.

CT data interpretation

MDCT images were retrospectively studied by two radiologists (A.C.T, V.T.), unaware of the final histological results. No clinical information, other than the diagnosis of primary cervical carcinoma was available at the time of CT data interpretation. Any discrepancy was resolved by consensus.

The CT images were evaluated for the following: (a) tumor detection, (b) tumor maximal diameter, (c) tumor extension to the uterine body and/or the vagina, (d) parametrial invasion and (e) presence of pelvic lymph node metastases. A tumor confined to the cervix was detected as centrally located, with smooth lateral margins and normal parametrial fat (Fig. 1 on page 5, 2 on page 5). Sagittal and coronal multiplanar reformations and 3D-reconstructions were used to assess the craniocaudal extent of the neoplasm, and therefore the presence of invasion of the uterine body and/or the vagina.
by the carcinoma (Fig. 3 on page 6, 4 on page 6). Obliteration and haziness of the parametrial fat, irregularity or poor definition of the lateral cervical margins, tumoral mass extending into the parametrial fat and obliteration of the periureteral fat plane were considered as signs suggestive for parametrial invasion. Both transverse and coronal reformations were used to assess for parametrial extension (Fig. 5 on page 7, 6 on page 7, 7 on page 8). Pelvic lymph nodes greater than 1 cm in short-axis diameter were considered as abnormal [23-25].

CT stage was assigned for each cervical carcinoma. When the neoplasm was not detected at all, it was characterized as stage IA. The surgical-pathological stage was assigned on the basis of the operative findings and the histologic report. The recent modifications of the FIGO staging system were taken into consideration (Table 1) [7, 8].

**Table 1. FIGO staging system for carcinoma of the cervix uteri.**

<table>
<thead>
<tr>
<th>FIGO stage</th>
<th>Criteria</th>
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<tbody>
<tr>
<td><strong>Stage I</strong></td>
<td>carcinoma strictly confined to the cervix (extension to the uterine body should be disregarded)</td>
</tr>
<tr>
<td>IA</td>
<td>microinvasive carcinoma: stromal invasion with a maximum depth of 5 mm and no wider than 7 mm in horizontal spread</td>
</tr>
<tr>
<td>IA1</td>
<td>stromal invasion no greater than 3 mm in depth and no wider than 7 mm</td>
</tr>
<tr>
<td>IA2</td>
<td>stromal invasion greater than 3 mm, but not greater than 5 mm in depth and no wider than 7 mm</td>
</tr>
<tr>
<td>IB</td>
<td>clinically visible tumors confined to the cervix or preclinical lesions greater than stage IA</td>
</tr>
<tr>
<td>IB1</td>
<td>clinically visible tumor ≤ 4 cm in greatest diameter</td>
</tr>
<tr>
<td>IB2</td>
<td>clinically visible tumor &gt; 4 cm in greatest diameter</td>
</tr>
<tr>
<td><strong>Stage II</strong></td>
<td>carcinoma extending beyond the uterus, but not to the lower third of the vagina (may involve proximal vagina) or the pelvic wall</td>
</tr>
<tr>
<td>IIA</td>
<td>no parametrial invasion</td>
</tr>
<tr>
<td>IIA1</td>
<td>clinically visible tumor ≤ 4 cm in greatest diameter</td>
</tr>
</tbody>
</table>
IIA2  clinically visible tumor > 4 cm in greatest diameter

IIIB  parametrial invasion

Stage III  carcinoma extending to pelvic wall, and/or the lower third of vagina; and/or causing hydrenephrosis or non-functioning kidney

IIIA  extension to lower third of vagina, not to the pelvic wall

IIIB  extension to the pelvic wall and/or hydrenephrosis or non-functioning kidney

Stage IV  carcinoma extends beyond true pelvis or involves the mucosa of the urinary bladder or rectum (biopsy proven)

IVA  spread to adjacent organs

IVB  distant metastases

Images for this section:

Fig. 1: Stage IB1 non-keratinizing squamous cell carcinoma of the cervix (case 7). Transverse multiplanar reformation shows cervical enlargement and tumor hypodensity (asterisk). The neoplasm is confined within the cervix, with smooth, well-defined lateral cervical margins (small arrows).
Fig. 2: Stage IB1 non-keratinizing squamous cell carcinoma of the cervix (case 7). Sagittal multiplanar reformation shows cervical enlargement and tumor hypodensity. A small amount of air (long arrow) is seen within the mass.

Fig. 3: Stage IB1 non-keratinizing squamous cell carcinoma of the cervix (case 15). Sagittal 3D reformatted image shows cervical enlargement. The tumor (asterisk) is extending to the uterine body, and is detected mainly isodense, when compared to the normally-appearing myometrium (arrow).
Fig. 4: Stage IB1 non-keratinizing squamous cell carcinoma of the cervix (case 15). Coronal multiplanar reformatted image shows cervical enlargement. The tumor (asterisk) is extending to the uterine body, and is detected mainly isodense, when compared to the normally-appearing myometrium (arrow).

Fig. 5: Stage IIB keratinizing squamous cell carcinoma of the cervix (case 11). Sagittal reformatted image shows hypodense cervical carcinoma (asterisk), with the presence of air (long arrow).
**Fig. 6:** Stage IIB keratinizing squamous cell carcinoma of the cervix (case 11). Coronal multiplanar reformation depicts irregularity and poor definition of the lateral tumoral margins (small arrows), a finding suggestive of parametrial invasion, which was proved histologically.

**Fig. 7:** Stage IIB keratinizing squamous cell carcinoma of the cervix (case 11). Coronal 3D image depicts irregularity and poor definition of the lateral tumoral margins (small arrows), a finding suggestive of parametrial invasion, which was proved histologically.
Fig. 8: Stage IB1 adenosquamous cervical carcinoma (case 12). Sagittal reformation depicts a contrast-enhancing cervical tumor (arrow). Histology reported metastatic involvement of a left pelvic lymph node in this patient, which was not appreciated on imaging.

Fig. 9: Stage IIB non-keratinizing squamous cell carcinoma of the cervix (case 16). (a) Sagittal 3D reformation depicts cervical carcinoma with central hypodensity (asterisk), corresponding to necrosis on pathology. The tumor invades the proximal part of the uterus. No distention of the remaining normal part of the uterine cavity is seen (long arrow).
Fig. 10: Stage IIB non-keratinizing squamous cell carcinoma of the cervix (case 16). Coronal multiplanar reformation depicts cervical carcinoma with central hypodensity (asterisk), corresponding to necrosis on pathology. The lateral cervical margins (small arrows) are smooth and well-defined, suggesting no parametrial invasion. This was a false-negative diagnosis.
Results

Postoperative histology results showed the following staging: two patients had stage IA, eight had stage IB1 disease, five of stage IB2, one of IIA1, and two had stage IIB disease. The histologic types of uterine cervical carcinoma included squamous cell carcinoma (keratinizing n=2, non-keratinizing n=10, non-keratinizing and basaloid n=1, squamotransitional n=1), adenocarcinoma (endometrioid n=1, endometrioid and villoglandular n=1, endometrioid and mucinous n=1), and adenosquamous carcinoma (n=1). The maximal diameter of the neoplasms ranged from 0.5 cm to 6.5 cm (mean diameter: 3.5 cm) on pathology.

Table 2 shows the individual patients and the correlation of CT staging with surgical-pathologic staging results. MDCT detected 15 out of 18 (83%) carcinomas in this study. Detected neoplasms had a diameter ranging from 0.8 cm to 7 cm and a mean diameter of 3.6 cm. In 13 patients, the tumor was detected as mainly hypodense (Fig. 1 on page , 2 on page ), accompanied by cervical enlargement in 10 cases and the presence of air in four studies. In one patient, cervical carcinoma was predominantly isodense (Fig. 3 on page , 4 on page ), when compared to the normal myometrium and in one case predominantly contrast-enhancing (Fig. 8 on page ). Multidetector CT was not able to detect cervical tumor in three patients: two with microinvasive carcinoma (stage IA2, cases 3 and 5) and another with a neoplasm of 2.5 cm in diameter on histology (stage IB1, case 17), probably because the tumor had a similar enhancement pattern with the normal cervix in this case.

Tumor extension to the uterine body and the proximal part of the vagina was proved histologically in six (33%) and two (11%) patients, respectively in our material. MDCT proved accurate in all (100%) cases regarding the presence or absence of invasion of the uterus body. CT also diagnosed correctly the presence or absence of vaginal invasion in 17 out of 18 (94%) patients. Sagittal and coronal reformations, both multiplanar and 3D proved useful in delineating the superior and inferior extent of the neoplasm (Fig. 3 on page , 4 on page ). In one patient, multidetector CT was unable to depict microscopic invasion of the proximal vaginal wall by the tumor (case 11).

Thirty-six parametria (18 right and 18 left) in 18 patients were evaluated for tumoral spread. Four (11%) parametria in two patients showed tumor involvement, according to the final histologic diagnosis. MDCT had an overall accuracy of 92% (33 out of 36 parametria) in diagnosing the presence or absence of invasion. In 31 tumor-free parametria (true-negative cases), cervical carcinoma was detected confined to the cervix, with smooth, well-defined cervical margins, without prominent parametrial soft-tissue strands or a parametrial soft-tissue mass and preservation of the periureteral fat plane (Fig. 1 on page ). In two tumor-positive parametria (true-positive cases), there was irregularity and poor definition of the lateral cervical margins (Fig. 6 on page , 7 on page ), a finding proved to correspond to neoplastic involvement on histology. In one
patient, cervical tumor was seen confined within the cervix, with smooth, sharply-defined lateral margins (Fig. 9 on page , 10 on page , case 16); therefore, parametrial spread was not diagnosed on CT in this case, although proved on pathology. There was one false-positive case, with left parametrial invasion misdiagnosed on imaging, based on irregularity of the cervical margins. Subsequent pathologic confirmation did not confirm tumoral spread into the parametria in this patient (case 8). Both transverse and coronal reformations were used to assess the presence or absence of tumoral infiltration of the parametria.

Sixteen pelvic regions (eight right and eight left) in eight patients had surgical confirmation of pelvic lymph node status (cases 9-16), and four (25%) regions in three patients were found positive for lymph node metastases. There were 12 true-negative, 1 true-positive, and three false-negative results (overall accuracy: 81%), regarding the neoplastic involvement of pelvic lymph nodes. False-negative cases were lymph nodes, less than 1 cm in short-axis diameter.

The overall accuracy of multidetector CT in staging primary cervical carcinoma in this study was 83% (15/18). CT overstaged the tumor in one patient (case 8) and understaged the disease in two studies (cases 16 and 17).

**Table 2.** Correlation of CT staging and surgical-pathological staging (_: negative for tumor; +: positive for tumor; ND: not detected; R: right; L: left).

<table>
<thead>
<tr>
<th>Patient</th>
<th>Tumor diameter (cm)</th>
<th>Uterine body invasion</th>
<th>Vaginal invasion</th>
<th>Parametrial invasion</th>
<th>Lymph node metastases</th>
<th>Stage</th>
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<tbody>
<tr>
<td></td>
<td>CT</td>
<td>Histology</td>
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<td>3. 53</td>
<td>ND</td>
<td>0.5</td>
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<td>4. 70</td>
<td>4.3</td>
<td>4.5</td>
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<tr>
<td>5. 74</td>
<td>ND</td>
<td>&lt;0.7</td>
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<tr>
<td>6. 64</td>
<td>5</td>
<td>5.5</td>
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<td>7. 51</td>
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<td>8. 39</td>
<td>4.4</td>
<td>4.5</td>
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<tr>
<td>9. 42</td>
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<td>10. 39</td>
<td>4</td>
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Conclusion

Discussion

The FIGO staging classification system for cervical carcinoma was recently modified and the new staging system is in use, since the beginning of 2009 (Table 1) [7, 8]. FIGO committee encourages the use of cross-sectional imaging studies, more specifically MR imaging/CT for the assessment of the size of primary cervical carcinoma and stage of the disease [7, 8]. Clinical examinations, as pelvic examination under anesthesia, intravenous urography, cystoscopy and sigmoidoscopy are no longer considered mandatory [7, 8].

Computed tomography was used mainly to stage advanced cervical carcinoma, to monitor for tumor recurrence, to guide lymph node biopsies, to plan radiation therapy and to follow-up patients under therapy [2-4, 9-16, 26]. The main limitations of conventional and helical CT were difficulty in visualization of the primary carcinoma and low accuracy in detecting parametrial invasion [2-4, 9-16]. Multidetector CT with reduced scan time, thin slices and isotropic data greatly improved the diagnostic performance in the evaluation of gynecologic malignancies [19-22]. The ability to create multiplanar and 3D reformations, previously possible only with MRI is one of the major improvements of MDCT [17, 18].

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<tr>
<td>11.</td>
<td>4</td>
<td>5.5</td>
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<td>+</td>
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<td>(R,L)</td>
<td>+ (R)</td>
<td>(R,L)</td>
<td>IIB</td>
<td>IIB</td>
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<td>12.</td>
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<td>(L)</td>
<td>IB1</td>
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<td>2.4</td>
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<td>14.</td>
<td>3.5</td>
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<td>(L)</td>
<td>IIA1</td>
<td>IIA1</td>
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<tr>
<td>15.</td>
<td>4.2</td>
<td>4.5</td>
<td>+</td>
<td>+</td>
<td>-</td>
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<td>IB2</td>
<td>IB2</td>
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<tr>
<td>16.</td>
<td>7</td>
<td>6.5</td>
<td>+</td>
<td>+</td>
<td>-</td>
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<td>+</td>
<td>(R,L)</td>
<td>IB2</td>
<td>IIB</td>
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<td>17.</td>
<td>ND</td>
<td>2.5</td>
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<td>IA</td>
<td>IB1</td>
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<td>18.</td>
<td>1.3</td>
<td>1.5</td>
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<td>IB1</td>
<td>IB1</td>
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To our knowledge, this is the first study evaluating the diagnostic performance of a 16-row CT in the detection and local staging of primary cervical carcinoma. Our results showed a high accuracy (83%) in detecting carcinoma of the uterine cervix, especially when compared to the low accuracies (50%) of older CT scanners [9-16]. Furthermore, MDCT showed a high accuracy in the assessment of the size of the neoplasm, as it was found similar to that measured on the histopathology reports. Tumoral size is one of the most important prognostic factors and has a great impact on choice of therapy in patients with cervical cancer [2-5].

In this study, the overall accuracy in local staging was 83%, confirming the improved diagnostic performance of MDCT, compared to the low accuracies (ranging from 53% to 66%) of conventional and single-slice CT scanners [9, 13, 16]. MDCT was accurate in detecting tumor extension to the uterine body and the proximal part of the vagina. Multiplanar reformations and 3D-reconstructions were used for the interpretation of the CT data, since previous studies have reported that axial images are inaccurate in assessing the craniocaudal extent of primary cervical carcinoma [27]. Reformatted images in sagittal and coronal planes usually depict the superior and inferior extent of the tumor more accurately. This is known from the MR imaging, and it was also demonstrated with MDCT in this study. Three-dimensional reconstructed images have also the advantage of displaying the relationship of the primary tumor to the neighboring structures and therefore may be used for surgical planning.

The detectability of parametrial disease is crucial in guiding treatment options in patients with primary cervical carcinoma. In the present study, a high accuracy (92%) of MDCT in diagnosing the presence or absence of invasion of the parametrium was shown, confirming the improved diagnostic performance of multidetector CT in diagnosing parametrial infiltration, when compared to the low accuracies (30-58%) of conventional CT scanners [9-16].

The presence of lymph node metastases is another important prognostic factor, although not included in the FIGO classification [2-5]. Patients with pelvic lymph node metastases at CT have a lower 5-year survival rate free of disease [2]. CT detection of enlarged pelvic lymph nodes is considered equivalent to FIGO stage IIIB disease [2]. In this study, the mean accuracy rate of MDCT in detecting pelvic lymph node metastases was 81%, which is similar to that reported for conventional CT [9-16]. A possible explanation is that, although CT can easily detect lymph nodes larger than 1 cm in diameter, it is unable to appreciate and characterize lymph node architecture [2-5, 24, 25].

MR imaging is recommended as a reliable modality for the evaluation of invasive cervical cancer, with a high accuracy both in the detection of cancers at stage IB or higher and local staging of the disease [3-6, 28-31]. Multidetector CT provided satisfactory results in detecting and characterizing the local stage of primary cervical carcinoma in this study. A direct comparison of the diagnostic performances of both imaging techniques in diagnosing early-stage cervical cancer is mandatory. Among the advantages of MDCT
over MR imaging are the wide availability, low cost, reduced examination time, lack of bowel motion artifacts and fewer contraindications.

In conclusion, multidetector CT on a 16-row CT scanner is accurate in the detection and local staging of early-stage cervical carcinoma. Further studies comparing the accuracy of MDCT to that of MR imaging are needed to define whether MDCT will improve the diagnostic performance of the technique in the pretreatment evaluation of primary cervical carcinoma.

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Personal Information

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