Staging and follow up of cervical cancer

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Learning objectives

- To become familiar with initial staging and follow up features especially on MR imaging.

- To highlight the interaction between radiologist, radiation oncologist and surgeon.

- To review the aspects of radiation and post-operative changes and their impact on MR images.
Background

MR imaging provides excellent spontaneous soft tissue contrast of all female pelvic organs, permits a multiplanar exploration of the entire pelvis including lymph nodes and the pelvic floor especially on T2 weighted sequences. Therefore MR imaging is the modality of choice for the initial work-up of invasive cervical cancer.

This course reviews the technical aspects of the MR imaging exploration of the invasive cervical cancer such as choice of sequences, slice orientation, intra cavitary and intra venous contrast media injection for MR examination for initial staging, follow-up examination during radiation therapy (external radiotherapy and iratherapy) and suspected recurrence.

The imaging features encountered during initial staging such as parametrial, bladder, ureteral and rectal invasion are reviewed with particular emphasis on findings to guide fertility conserving surgery, external radiation therapy or iratherapy. These findings will be correlated to the FIGO classification for invasive cervical cancer.

Lymph node involvement of cervical cancer and its repercussions in MR imaging are highlighted.

During follow up especially of cervical cancer is treated by chemeradiation, post radiation changes of the pelvic organs and spaces can render the interpretation of MR images more difficult and the use of contrast enhanced T1 weighted SE MR images is useful to distinguish post radiation fibrosis from recurrence.
Findings and procedure details

1. Indications for MRI in uterine cervical cancer

· Staging of tumors stage 1B1 and over or smaller tumors if trachelectomy is being considered.

· Treatment follow-up (after brachytherapy and chemoradiation therapy) and detection of tumor recurrence.

There is no consensus for:

· The MRI time-delay after treatment: it varies from 3 weeks to 6 months; the majority recommends MRI 3-6 months after completion of chemoradiation therapy and brachytherapy.

· The frequency of follow-up: Some ESUR members perform yearly follow-up MRI for 5 years and some only if there are symptoms of recurrence.

2. Technical requirements for MRI in uterine cervical cancer

a. Patient Preparation

There was no consensus among regarding the type of preparation before pelvic MRI. Nevertheless, different types of patient preparations have been suggested in order to improve the quality of the examination (antiperistaltic agent or vaginal/rectal opacification with sterile gel).

b. Imaging Sequences

At least:

· two T2-weighted sequences obtained in the sagittal and oblique (perpendicular to the cervical canal) planes

· and T1W sequences of the upper abdomen and pelvis.

T2w sequences are the best sequences to detect the cervical tumor and its extension to the uterus, parametria and the adjacent organs.

Performing T2w sequences in two orthogonal planes such as sagittal and oblique images must be acquired perpendicularly to the long axis of the cervical canal.

A coronal T2w sequence on the pelvis with thin slices (3-4 mm/0.4 mm) to assess parametrial extension.
The use of fat suppression is not recommended as the presence of parametrial fat can lead to better tumor delineation.

Slice thickness varied from 3 to 6 mm, with a 0.25 gap.

For optimal image quality, T2-weighted images covering the pelvis should be acquired with a small FOV (20-25 cm) and ideally with a 512×512 matrix.

T1w sequences are very useful to evaluate for presence of lymphadenopathy, bone metastases and also in the rare occasion of hematometria. Nevertheless, lymph node evaluation can also be done accurately on T2w axial sequences.

Images of the abdomen (from the level of the renal veins to the pelvic brim) to evaluate for presence of abnormal lymph nodes. Both T1 and T2-weighted images can be used. This obviates the need for an additional CT of the abdomen.

Diffusion weighted imaging (DWI) seems to be a very promising emerging technique in the evaluation of uterine cervical cancer. Cervical carcinoma has a lower apparent diffusion coefficient (ADC) compared to the normal cervix. The ADC increases after chemoradiotherapy. There is a variability in the B-values used with a range of B values between 500 and 1000 bms/−2. DWI may be helpful in detection of residual tumor or suspicious lymph nodes after chemoradiotherapy, and might be competitive with PET-imaging.

3. MRI Reporting

The following check list is helpful for a comprehensive and easy to read report.

a. Description of the lesions

· Cervical tumor is depicted on T2w images as a hyperintense mass compared to the cervical stroma (fig 1).

· Tumor size (in three dimensions) must be evaluated in at least two orthogonal views; it is crucial to give precise measurements as size of the tumor can dictate treatment options.

· Fertility sparing surgery is possible with tumors <2 cm whereas patients with tumors >4 cm may undergo chemoradiotherapy rather than radical surgery.

b. Local staging

· Vaginal extension: precise description should be given if the extension is anterior or posterior.

If the lesion reaches the 2/3 of the upper vagina, it is a FIGO IIA;
If the lesion invades the 1/3 inferior part of the vagina, it is a FIGO IIIA.

- **Parametrial extension:** stromal invasion is present if there is a disruption of the hypointense line circumscribing the cervix on oblique T2w images.

Parametrial invasion is present if in addition to the stromal invasion there is tumor present in the parametrium, a spiculated tumor parametrial interface or tumor encasement of the peri-uterine vessels.

Presence of **hydronephrosis** is consistent with parametrial invasion.

- **Isthmic extension:** clinical evaluation is not accurate in case of isthmic invasion (fig 2).

The reporting should include it because positioning of brachytherapy coils might be dependant of the level of isthmic tumor extension.

c. **Lymph node staging (fig 3)**

FIGO classification does not include the nodal status.

Yet, lymph node spreading is one of the most important prognostic factors in cervical carcinoma.

Accuracy of MRI is low for lymph node staging, with a sensitivity varying from 38 to 89%, and a specificity from 78 to 99%.

Size criterion for a suspicious lymph node is a short axis superior to 1 cm, in the pelvis or the abdomen.

However, smaller lymph nodes may be malignant, especially in the pelvis; therefore it is important to take in account other features of malignancy such as round shape, irregular margins, signal intensity similar to the primary tumor and presence of necrosis.

===> staging:

**FIGO 2009**

**Stage I** The carcinoma is strictly confined to the cervix (extension to the corpus would be disregarded)

**IA** Invasive carcinoma which can be diagnosed only by microscopy, with deepest invasion #5 mm and largest extension #7 mm

**IA1** Measured stromal invasion of #3.0 mm in depth and extension of #7.0 mm
IA2 Measured stromal invasion of N3.0 mm and not N5.0 mm with an extension of not N7.0 mm

IB Clinically visible lesions limited to the cervix uteri or pre-clinical cancers greater than stage IA

IB1 Clinically visible lesion #4.0 cm in greatest dimension (fig 4)

IB2 Clinically visible lesion N4.0 cm in greatest dimension

Stage II Cervical carcinoma invades beyond the uterus, but not to the pelvic wall or to the lower third of the vagina

IIA Without parametrial invasion (fig 5)

IIA1 Clinically visible lesion #4.0 cm in greatest dimension

IIA2 Clinically visible lesion N4 cm in greatest dimension

IIB With obvious parametrial invasion (fig 6)

Stage III The tumor extends to the pelvic wall and/or involves lower third of the vagina and/or causes hydronephrosis or non-functioning kidney

IIIA Tumor involves lower third of the vagina, with no extension to the pelvic wall (fig 7)

IIIB Extension to the pelvic wall and/or hydronephrosis or non-functioning kidney (fig 8)

Stage IV The carcinoma has extended beyond the true pelvis or has involved (biopsy proven) the mucosa of the bladder or rectum. A bullous edema, as such, does not permit a case to be allotted to Stage IV

IVA Spread of the growth to adjacent organs (fig 9, 10, 11, 12, 13)

IVB Spread to distant organs

d. Evaluation of Tumor Response to Treatment

· Chemoradiotherapy followed by brachytherapy is the standard treatment for patients with locally advanced uterine cervical carcinoma (> IB1 FIGO stage).

· Surgery is indicated for most patients with FIGO stage IB or IIA cancer of the cervix. It is usually avoided in case of complete response following chemoradiotherapy treatment, due to its high rate of urinary side effects (incontinence, uterine distension, chronic bladder infection …).
Tumor response evaluation is based on three criteria: clinical examination, PAP smear analysis and post treatment MR evaluation.

After treatment, MR protocol is the same as for cervical cancer staging, but IV injection is recommended.

MR criteria for a complete response include:

- No lesion seen in the cervix or in the adjacent anatomic areas
- Homogeneous hypointense cervical stroma
- Homogeneous and delayed intravenous contrast medium uptake of the cervix after IV injection.

Interpretation and performance of MRI in the follow-up setting are lower compared to the primary staging tumor detection.

It is useful to compare the post treatment images with the pre-treatment images to facilitate tumor detection and re-staging.

**Appearance after Surgery**

The MR imaging appearances of the central pelvis are similar after radical hysterectomy. In addition to absence of the uterus, the vaginal fornix typically forms a linear soft-tissue configuration at MRI following hysterectomy.

Sagittal plane MRI is useful for demonstrating the normal vagina wall. It is confirmed by visualizing a smooth, low-signal-intensity muscular wall on T2-weighted MR images. In some cases, however, fibrotic scar tissue is present at the vaginal vault. The scar demonstrates medium to low signal intensity on T2-weighted MR images. Metallic clips along the pelvic side wall can be detected at the site of lymph node dissection at MRI, as low-signal-intensity foci.

**Appearance after Radiation Therapy**

The definition of primary healing after radiation therapy is a cervix covered with normal epithelium or obliteration of the vaginal vault without evidence of ulceration or discharge. After completion of radiation therapy, clinical treatment (physical examination combined with evaluation of tumor markers) as well as imaging studies such as MRI are primarily intended for early detection of recurrent cervical carcinoma.

An early (2-3 months) and significant decrease in the signal intensity and volume of the tumor indicates a positive response to radiation therapy and a high probability of complete remission. The findings of reconstitution of the normal zonal anatomy of the cervix and
the presence of homogeneous low-signal-intensity cervical stroma at MR imaging are reliable indicators of a tumor-free postirradiation cervix.
**Fig. 1:** Sagittal T1W (a), T2W (b) and T1W image after injection of contrast medium (c): tumoral mass of the anterior lips of cervix hyperintense on T2, hypointense on T1 with important enhancement after injection of contrast medium.

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Fig. 4: Sagittal (a) and coronal (b) T2W image: tumoral mass (arrow) measuring 15x5 mm confined to cervix without invading stroma or parametria : stage IB 1.

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**Fig. 5:** Sagittal and axial T2W images. Tumoral cervical mass isointense on T2 invading upper # of the vagina (arrow): Stage IIA, with isthmic invasion (arrowhead) and hydrometry (star).

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Fig. 7: Sagittal T1w images before (a) and after (b) injection of contrast medium: tumoral cervical exophytic mass invading the anterior vaginal wall and the lower third of vagina: Stage IIIA

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**Fig. 2:** Sagittal and axial T2W images. tumoral cervical mass with isthmic invasion (arrow) leading to an hydrometry (star).

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Fig. 6: Sagittal and axial T2W images. Tumoral cervical mass invading the anterior vaginal wall and the left parametria. Stage IIB.

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Fig. 8: Sagittal (a) and axial (b) T2W images with URO-MRI (c,d): Tumoral cervical mass invading the anterior vaginal wall and parametria (arrow). The uro-MRI shows distension of the left excretory system without cystic involvement (arrowhead): Stage IIIB.

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Fig. 9: Sagittal (a) and axial (b) T2W images. Tumoral cervical mass isointense on T2 invading the cystic posterior wall with endoluminal mass: Stage IVA.

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Fig. 10: Sagittal (a) and axial (b) T2W images and sagittal T1W images with contrast medium (c,d): tumoral cervical mass hyperintense on T2, invading the posterior cystic wall: Stage IVA.

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**Fig. 11:** Axial T1W image (a) and axial (b) and sagittal (c) T1W images with contrast medium: Tumoral cervical mass with isthmic invasion (arrow white head), the upper third of vagina (arrow) the cystic wall (empty arrow); and parametria (arrow black head) : Stage IVa.

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**Fig. 12:** sagittal T2W (a) and axial T1W image with contrast medium (b): tumoral cervical mass with rectal invasion (irregular thickening) : Stage IVA.

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**Fig. 3:** coronal (a) and axial (b) T2W images: left iliac adenopathy.

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**Fig. 13:** axial (a) T1w image without injection of contrast medium, and axial (b) and sagittal (c) T1w images with injection of contrast medium, and uro-MRI (d): Tumoral cervical mass (full arrow), with endometrial invasion, the posterior cystic wall (arrow white head), and the sigmoid bowl(arrow black head) with bilateral iliac adenopathy (empty arrow) and distension of excretory system (d) : Stage IVa N+.

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**Fig. 14:** Sagittal (a) and axial(b) T2W image before radiation-chemotherapy; Sagittal (c) and axial(d) T2W image after radiation-chemotherapy: (a,b): cervical tumor (white star) with bilateral parametrial invasion (white arrow) and lymphatic invasion (arrowhead): Stage IIIB N+. (c, d): uterine atrophy with tumor confined to cervix (black star) without parametrial or lymphatic invasion (black arrow).

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Conclusion

MR imaging is the imaging modality for evaluation of initial tumor volume and extension, response to treatment and to rule out recurrence.
References

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