

MRI OF CERVICAL CANCER: STAGING, PROGNOSTIC IMPLICATIONS AND PITFALLS



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Goals/Objectives:

- ✓ Provide an overview of the revised FIGO staging system for cervical cancer with relevant examples of each stage on MRI.
- ✓ Review prognostic factors of cervical cancer, treatment implications, and criteria for adequate treatment response.
- ✓ Present some of the pitfalls of cervical cancer imaging on MRI.

Target Audience:

- ✓ Radiology residents, Body Imaging fellows and attendings

Disclosures:

- ✓ None

INTRODUCTION – CERVICAL CANCER

- Most common gynecologic malignancy worldwide and third most common gynecologic malignancy in the United States.
- Introduction of cervical cancer screening programs and improved treatment strategies have caused a reduction in mortality rates in industrialized nations¹.
- Staging recommended by International Federation of Gynecology and Obstetrics (FIGO) is widely adopted both for therapy planning and post-therapy follow-up.
- However FIGO staging, usually based on only clinical assessment, has shown to be inaccurate in the estimation of the actual tumor extent².
- Cervical carcinoma is a relatively slow-growing disease, usually invading the vagina and the paracervical space along the parametrium and uterosacral ligaments. Bladder, rectum, pelvic and para-aortic lymph nodes may be invaded in later stages.

USE OF MRI IN CERVICAL CANCER

- MRI of the pelvis is the most reliable **imaging** modality for staging, treatment planning and follow-up of cervical cancer. Often complementary to clinical assessment, which currently remains the reference standard.
- MRI can accurately evaluate the extent of disease because of its high spatial and contrast resolution for pelvic tissues and organs.
- Since clinical implications and therapeutic strategies for cervical cancer treatment vary tremendously according to the degree of tumor extension, familiarity with relevant MRI findings is essential for radiologists.

NORMAL CERVIX



Trilaminar pattern of signal intensity:

1. High signal intensity endocervical mucosal glands
2. Low signal intensity stroma
3. Intermediate signal intensity smooth muscle

REVISED FIGO STAGING OF CERVICAL CANCER³

- Implemented in 2009
- Three changes which affect imaging and interpretation:
 - 1) Use of diagnostic imaging is now **recommended** (although not mandatory).
 - 2) Stage IIA subdivided to IIA1 (<4cm) and IIA2 (>4cm) to reflect recent data correlating tumor size and patient outcome.
 - 3) Cystoscopy and proctoscopy are no longer mandatory. T2-weighted MR imaging accurately depicts bladder (sensitivity, 75%) and rectal (sensitivity, 71%) involvement with nearly 100% negative predictive value.

REVISED FIGO STAGING

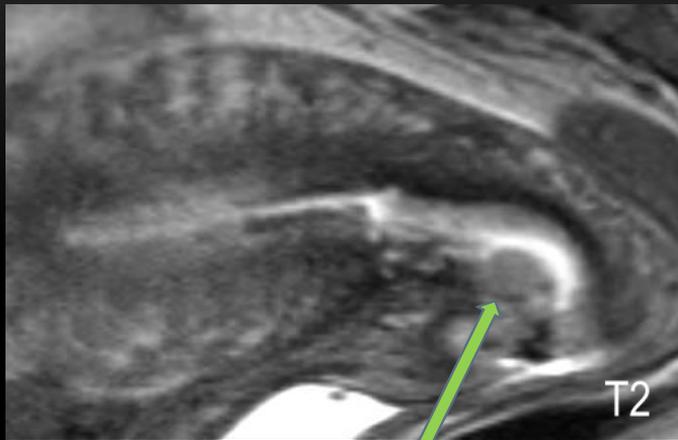
- IA1 Confined to the cervix, diagnosed only by microscopy with invasion of < 3 mm in depth and lateral spread < 7 mm
- IA2 Confined to the cervix, diagnosed with microscopy with invasion of > 3 mm and < 5 mm with lateral spread < 7mm.
- IB1 Clinically visible lesion or greater than A2, < 4 cm in greatest dimension
- IB2 Clinically visible lesion, > 4 cm in greatest dimension

- IIA1 Involvement of the upper two-thirds of the vagina, without parametrial invasion, < 4 cm in greatest dimension
- IIA2 > 4 cm in greatest dimension
- IIB With parametrial involvement

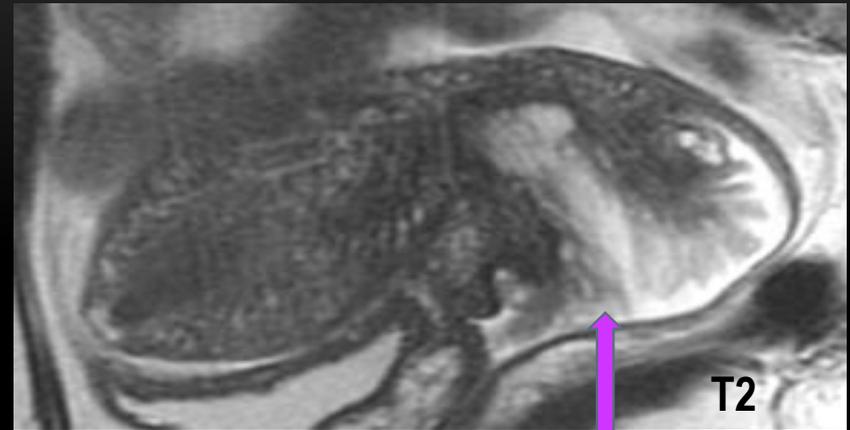
- III Tumor extends to pelvic wall and/or involves lower third of vagina and/or causes hydronephrosis
 - IIIA Tumor involves lower third of vagina, no extension to pelvic wall
 - IIIB Tumor extends to pelvic wall and/or causes hydronephrosis or nonfunctional kidney

- IV Tumor invades mucosa of bladder or rectum and/or extends beyond true pelvis
 - IVA Tumor invades mucosa of bladder or rectum
 - IVB Tumor extends beyond true pelvis

Stage IB: Earliest detectable stage on imaging

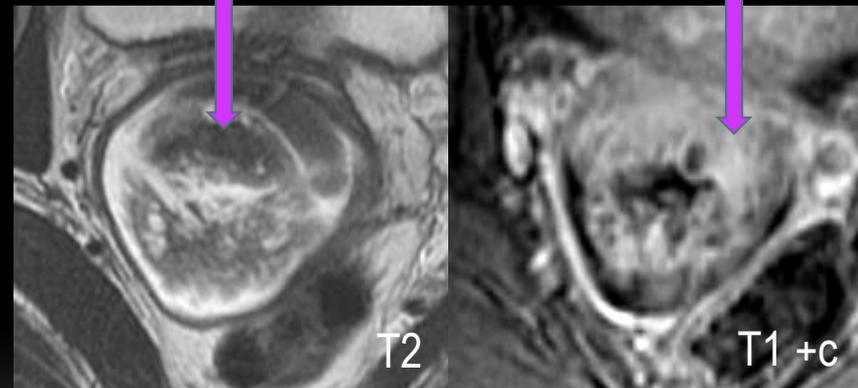


Stage IB1

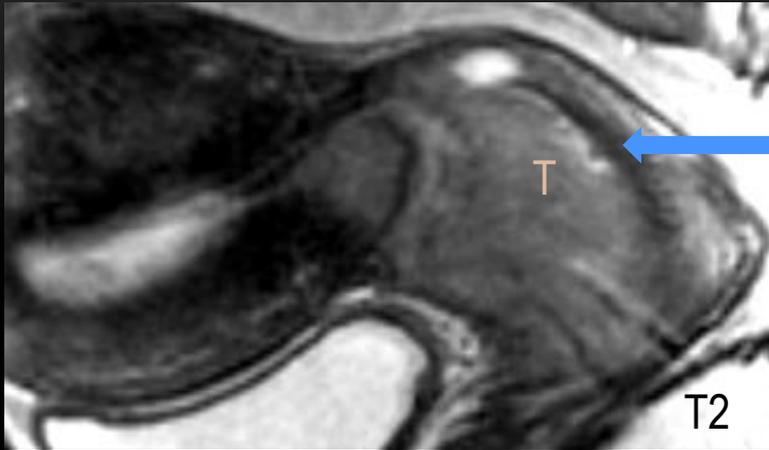


Stage IB2

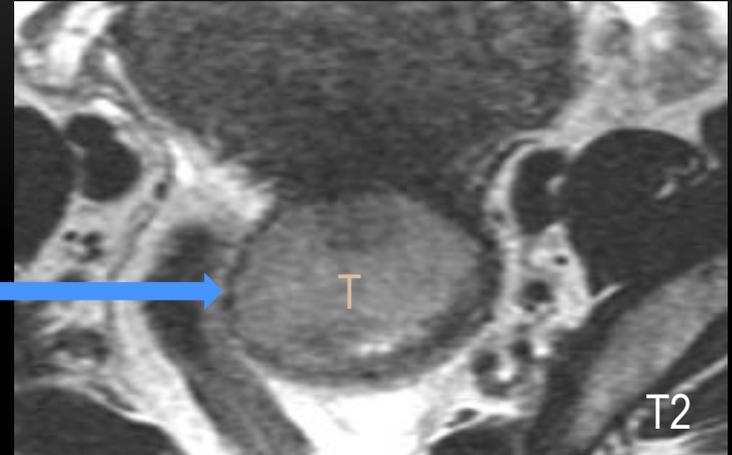
Pathology proven **Stage IB1 (<4cm)** and **Stage (IB2 >4cm)** cervical neoplasms demonstrate T2 hyperintense signal confined to the cervix, with no vaginal extension.



Stage IIA: Newly subdivided based on size

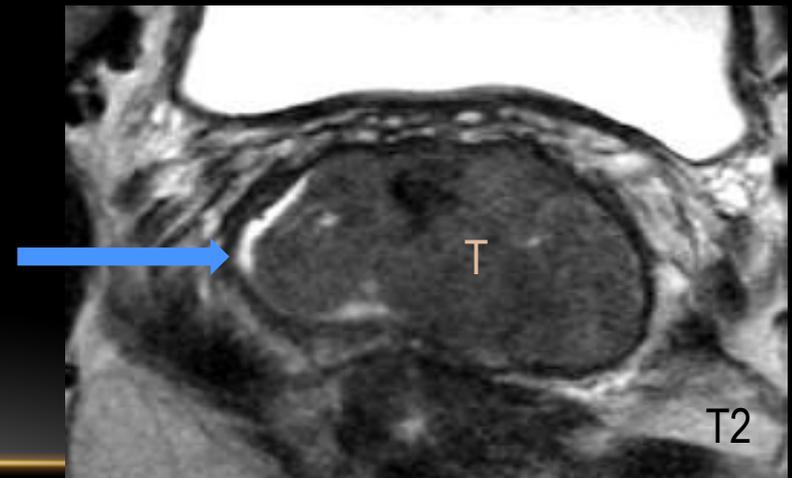


Stage IIA1



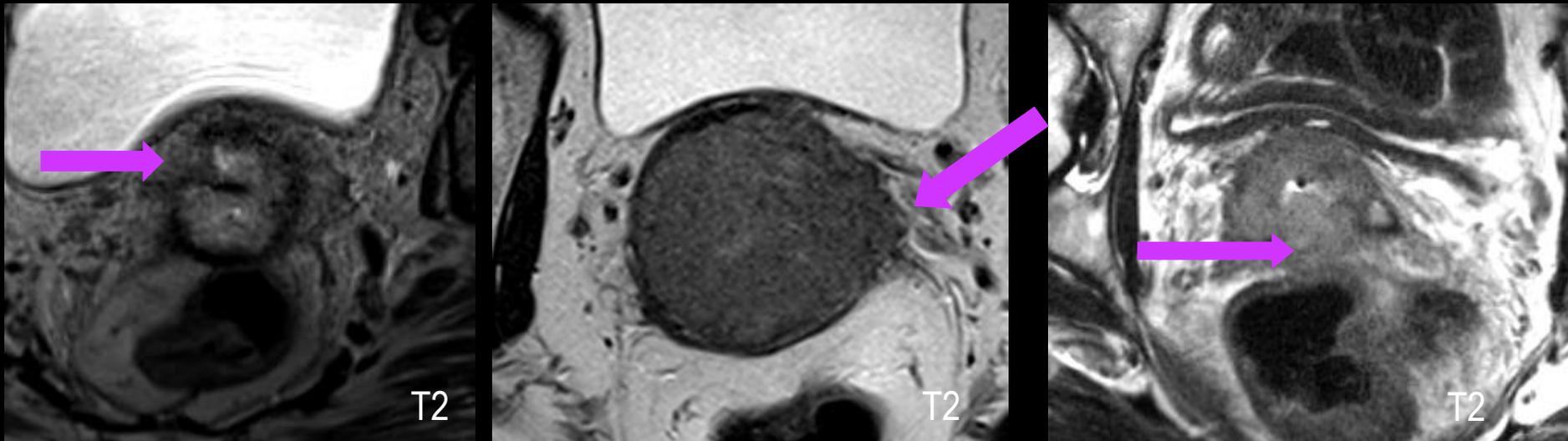
Stage IIA2

Pathology proven **Stage IIA1 (<4cm)** and **Stage IIA2 (>4cm)** cervical neoplasms demonstrate T2 hyperintense signal (T), involve the upper vagina but do not demonstrate parametrial extension. Note intact T2 hypointense cervical stroma (arrows).



Stage IIB: Parametrial invasion

- Complete disruption of the cervical stroma with nodular or irregular tumor signal intensity extending into the parametrium is a reliable sign of invasion.
- Contraindication to surgery!



Parametrial invasion in three different patients (arrows): There is loss of complete ring of low T2 signal stroma and associated soft tissue extension.

**Note that linear stranding around the cervical mass alone is not diagnostic of parametrial invasion, as it may also be seen with peritumoral inflammatory tissue (especially post treatment).*

Stage IIIA

IIIA: Tumor involves lower third of vagina, no extension to pelvic wall

T2 sagittal image demonstrates cervical tumor (T) with invasion of the lower one-third of the vagina (arrow).



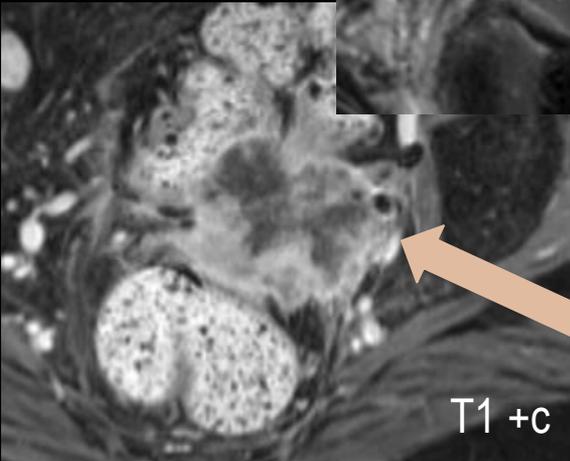
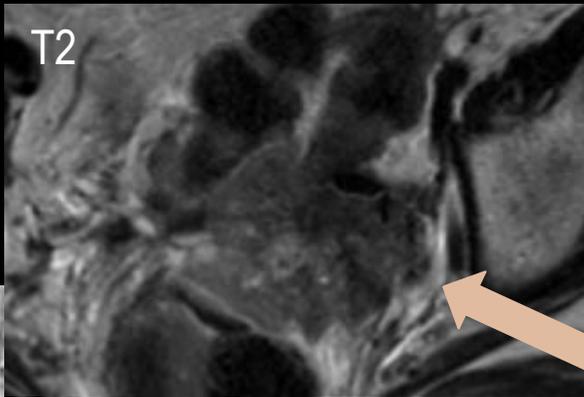
For the purposes of staging, invasion of the lower one-third of the vagina implies modification of radiation therapy strategy.

Stage IIIB

IIIB: Tumor extends to either pelvic wall and/or causes hydronephrosis or nonfunctional kidney

Axial T2 and post-contrast T1 images demonstrate tumor extension to left pelvic sidewall (arrows)

Axial and coronal T2 images in a different patient demonstrate left hydroureter (arrows) caused by cervical mass encasement (arrow)



Ureteral obstruction at the level of the tumor is considered to be an indication of pelvic wall invasion.

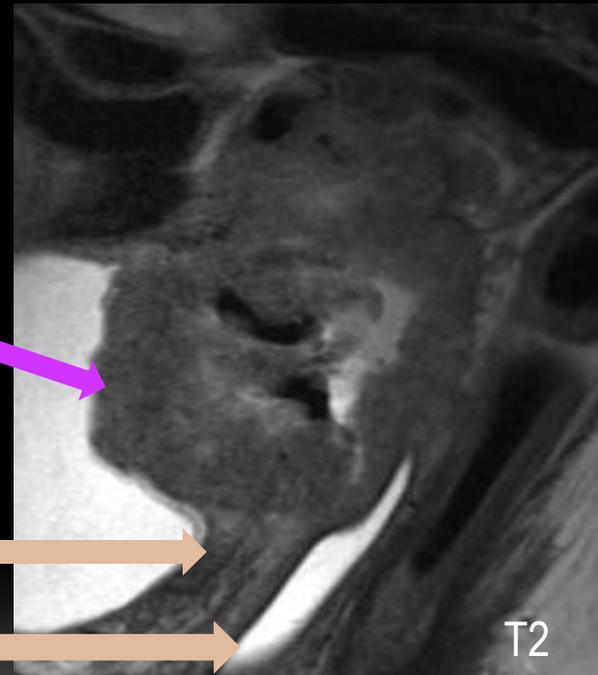
Stage IVA: Tumor invades mucosa of bladder or rectum

Bladder or rectal invasion can be diagnosed when disruption of their normal hypointense walls is seen at T2-weighted imaging, with or without a mass protruding into the lumen.

Sagittal T2 image demonstrates a bulky cervical mass invading the posterior bladder wall (arrow).

Vagina →

Free fluid →



T2

Stage IVA: Tumor invades mucosa of bladder or rectum

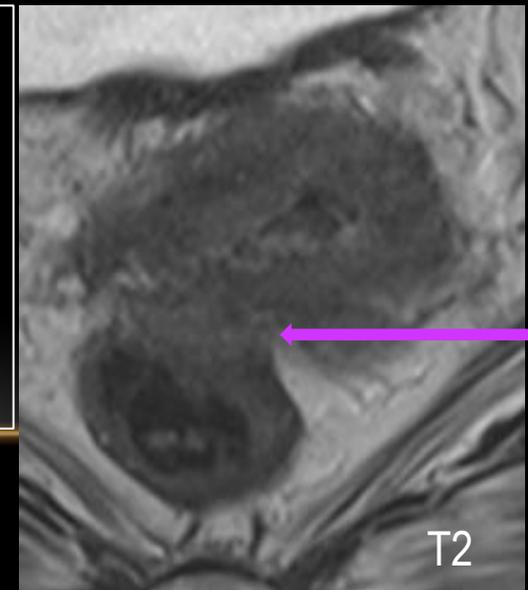
- Although invasion of the bladder or rectum is rare in cervical carcinoma, mandatory endoscopic assessment of these organs was part of the **standard** FIGO clinical staging system.
- According to the **revised** FIGO system, cystoscopy or proctoscopy are no longer routine. The absence of bladder or rectal invasion can be diagnosed confidently with **MRI**.



Rectal invasion in two different patients:

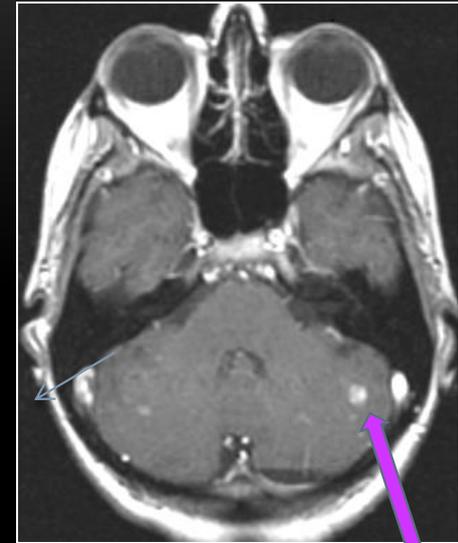
Top image: *Sagittal T2 demonstrates invasion of anterior rectal wall (arrow).*

Bottom image: *Axial T2 demonstrates loss of a fat plane between cervical neoplasm and anterior rectal wall (arrow)*

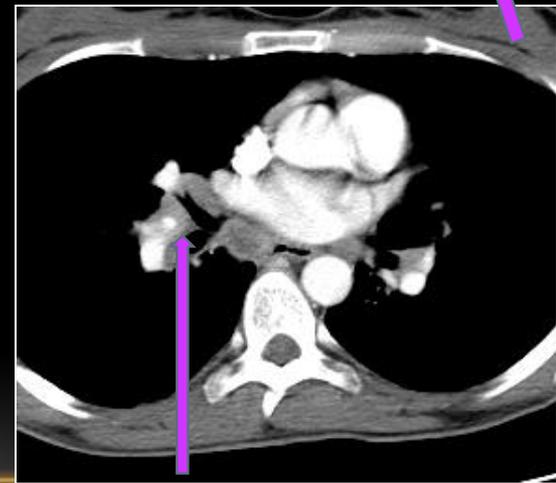


Stage IVB: Tumor extends beyond true pelvis

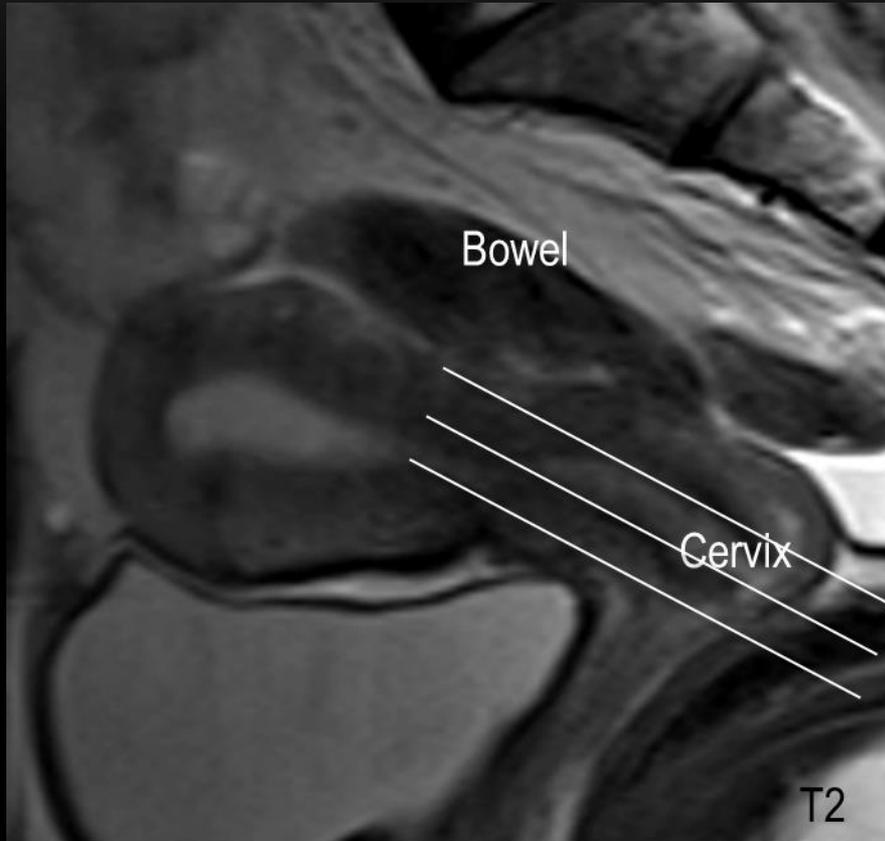
- The incidence of distant metastases increases with the stage of disease: 3% in stage IA to 75% in stage IVA⁴.
- Common hematogenous metastases to lungs, liver, brain, and bones.



56-year-old female with cervical neoplasm (not shown) demonstrates brain and mediastinal metastases (arrows).



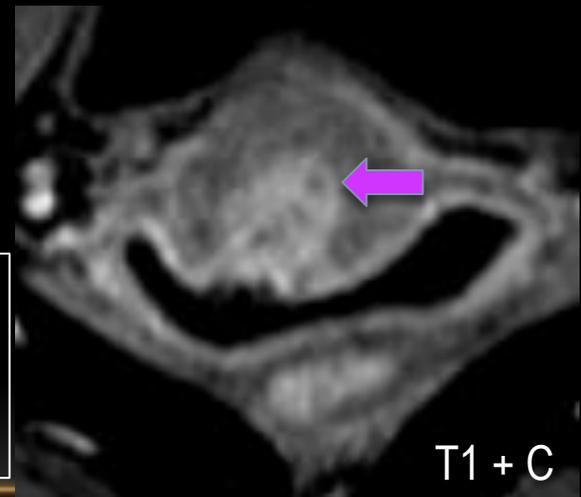
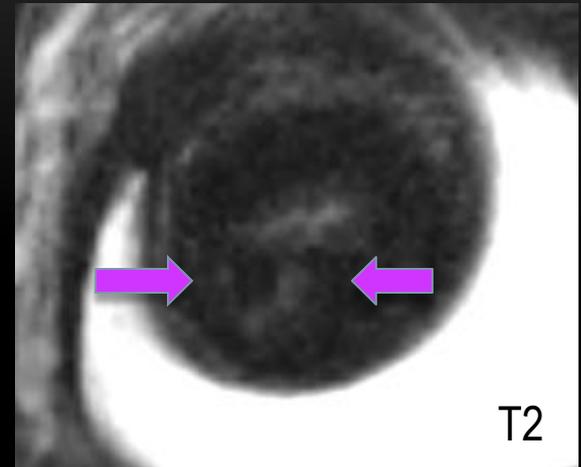
TECHNICAL CONSIDERATIONS



- ❖ High resolution T2-weighted imaging is the mainstay for tumor detection
 - ❖ Oblique axial T2W images planned perpendicular to the cervical long axis (image) provide more accurate assessment of stromal involvement and parametrial invasion.
 - ❖ Fat-suppressed sequences can be useful for the evaluation of parametrial involvement.
- ❖ Complementary sequences include:
 - ❖ Post contrast T1 weighted
 - ❖ Diffusion weighted imaging

Role of IV contrast

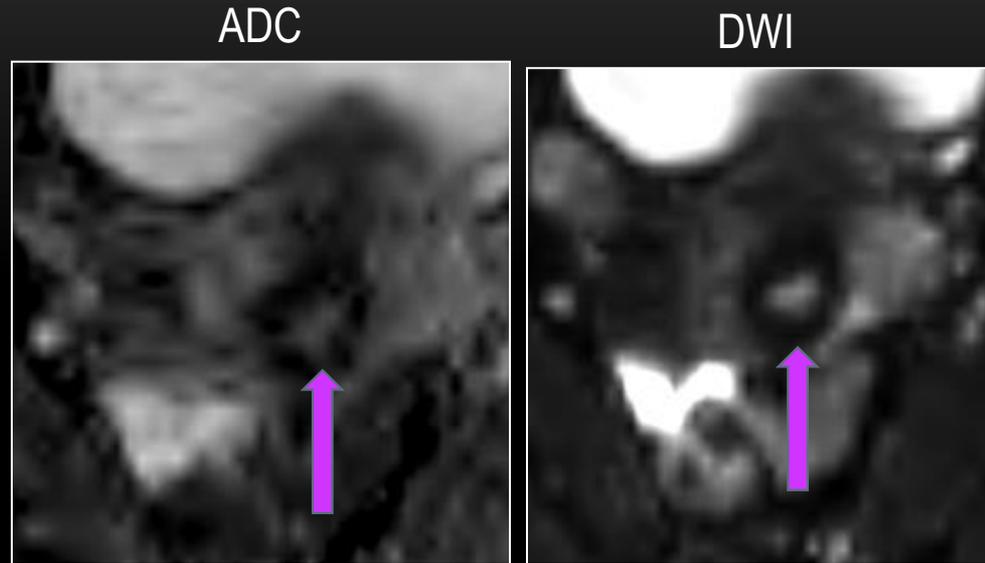
- Wide variation in the literature regarding use of IV contrast.
- Cervical carcinoma is better defined at T2WI, however detection of small tumors may be improved with IV contrast secondary due to their early enhancement relative to the cervical stroma⁵.
- Improves accuracy of diagnosing bladder and rectal invasion.
- Useful in the post-treatment setting to differentiate residual or recurrent tumor from radiation fibrosis.
- Helps to delineate complications of treatment, such as fistulas.



Axial T2 (top) and post contrast T1 (bottom) images demonstrate a poorly defined cervical tumor (arrows) that is subtle, mildly hyperintense on T2 and more readily visualized after administering IV contrast.

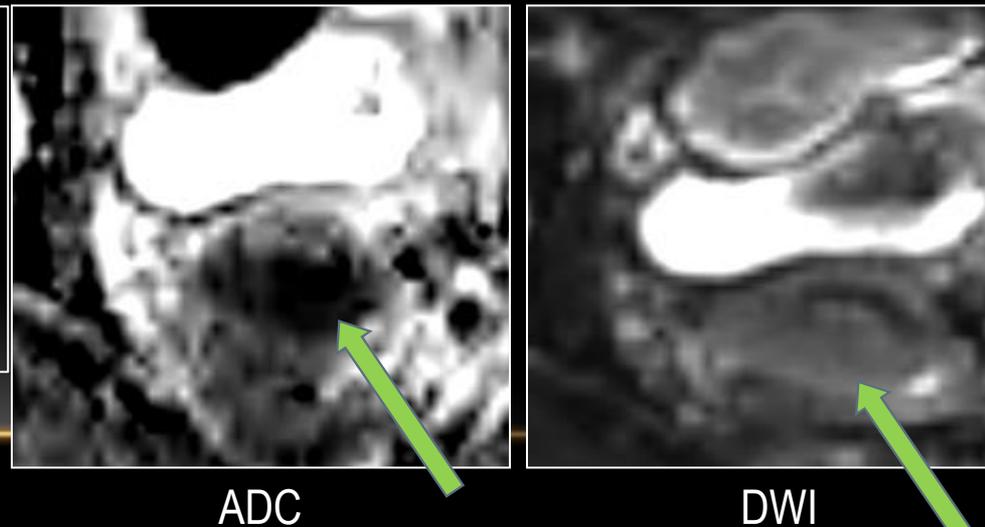
Role of Diffusion Weighted Imaging

- DWI can be applied to the detection of cervical cancer because of its superior disease contrast with normal tissue⁶.
- It is complimentary to T2WI in recognizing early-stage disease.
- ADC values can be a useful tool in monitoring response to therapy.



Top Images: Normal cervix demonstrates uniformly hypointense intact cervical stroma (arrows).

Bottom Images: Cervical neoplasm (arrows) demonstrates restricted diffusion.



Prognostic Factors

Overview

- Prognostic factors vary depending on treatment paradigm and whether clinical or surgical staging is utilized.
- Three factors that most accurately correlate with disease-free survival:
 1. lymphatic involvement by tumor
 2. tumor size
 3. depth of stromal invasion
- Depth of stromal invasion (assessed on pathology) is the most important and reproducible prognostic factor



Sagittal T2 image shows a large cervical tumor (arrow) involving the lower uterine corpus.

Disease free survival does not correlate with age, status of the surgical margins, quadrant involved or uterine extension.

Prognostic Factors

Nodal disease:

- Although not part of the FIGO staging system, it remains an important prognostic factor.
- The presence of metastatic lymph nodes indicates a worse prognosis within EACH given stage.
- 5% of early stage cervical cancers may have unsuspected adenopathy versus 55% of stage IV cervical cancers⁷.

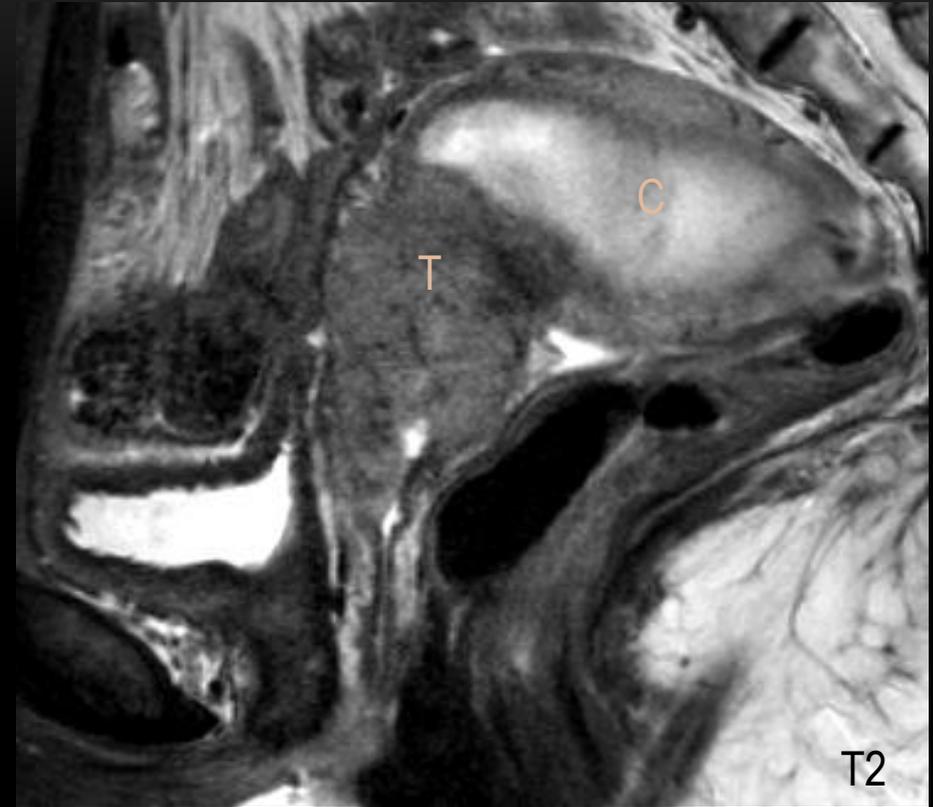


Axial T2 image demonstrates a pathologically enlarged left common iliac lymph node (arrow) in a patient with cervical neoplasm (not shown).

Prognostic Factors

Tumor size:

- The shape and direction of growth should be noted as they are important for brachytherapy planning.
- The size of the lesion may at times be overestimated on T2-weighted imaging due to inflammation or edema; post contrast images may be used.
- The craniocaudal diameter of the tumor is a critical factor in predicting prognosis after radiation therapy.
- Fertility sparing surgery is possible with tumors < 2 cm, whereas tumors > 4 cm may undergo chemo radiotherapy.



Sagittal T2 image demonstrates a bulky tumor (T) extending into the superior two thirds of the vagina and obstructing the uterine corpus (C).

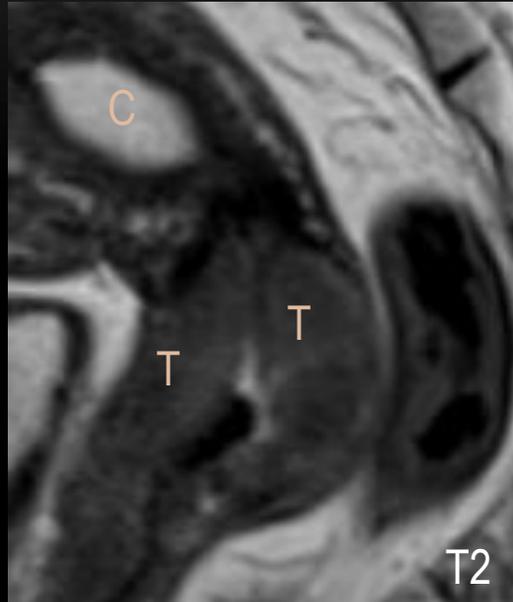
TREATMENT RESPONSE

- MR imaging is 78% accurate in evaluation of tumor response; in 22% of patients, however, benign conditions are not distinguishable from tumor⁸.
 - There is no consensus in the reviewed literature regarding indication of MRI for routine follow-up of cervical carcinoma after chemoradiation or surgery.
 - After trachelectomy, MRI at 6 months and 1 year is advised due to high recurrence rate.
-

Treatment Response

MR criteria for a complete response include:

1. No lesion seen in the cervix or in the adjacent anatomic areas.
2. Homogeneous hypointense cervical stroma.
3. Homogeneous and delayed intravenous contrast uptake of the cervix.



Left: Large cervical carcinoma (T) obstructing the uterine corpus (C) at initial imaging.

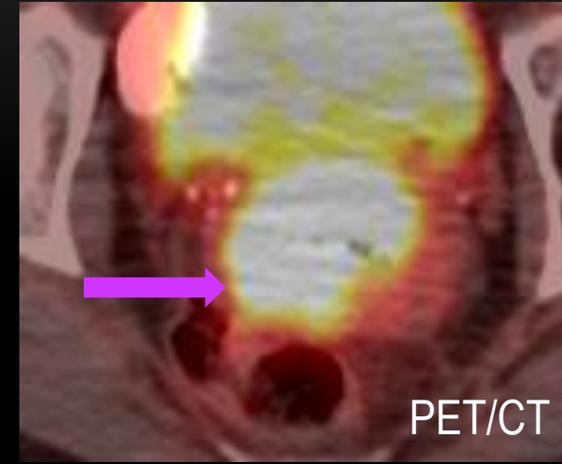
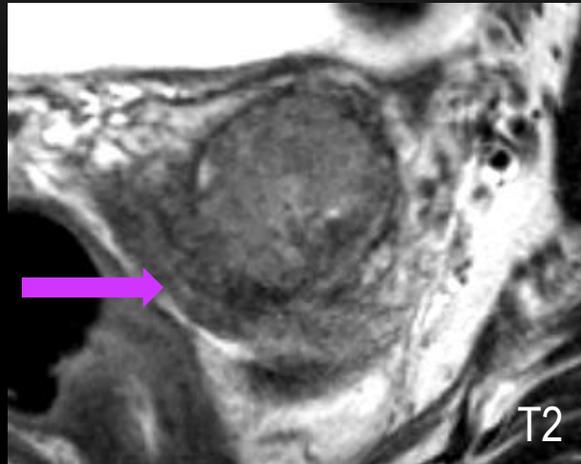
Right: Post-chemoradiation imaging demonstrates complete resolution of the mass, now with visualization of the hypointense cervical stroma (arrow).

Patient also developed severe cervical stenosis after radiation with improved but residual obstruction of the uterine corpus (C).

PITFALLS

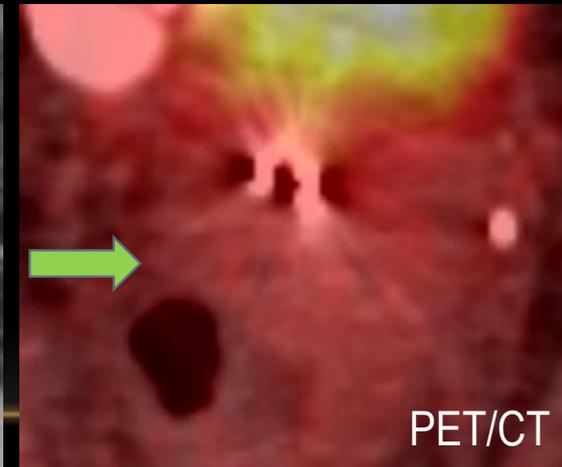
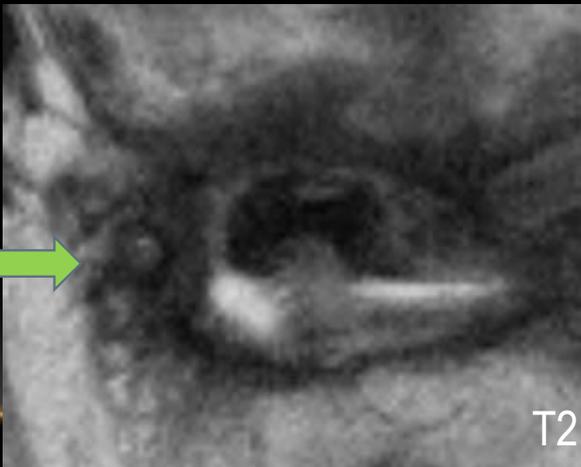
False positive parametrial extension

Axial T2WI showing large cervical mass extending into the right parametrium with corresponding avid FDG uptake on PET/CT (arrows).



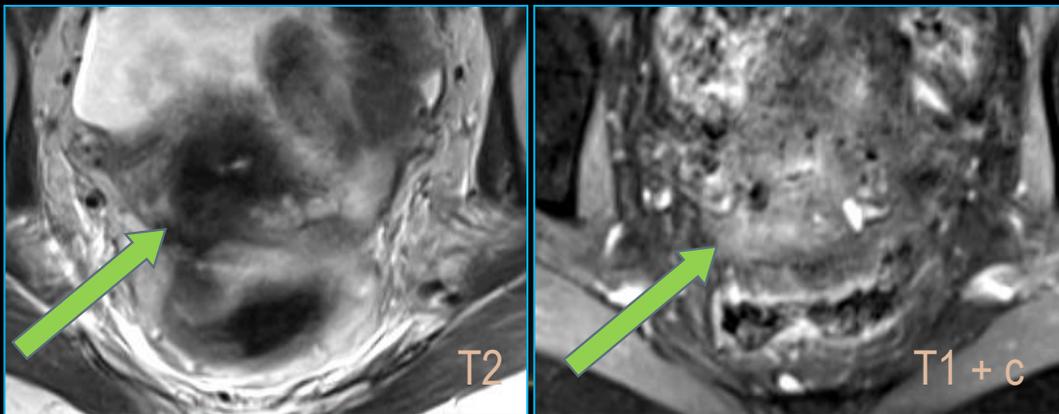
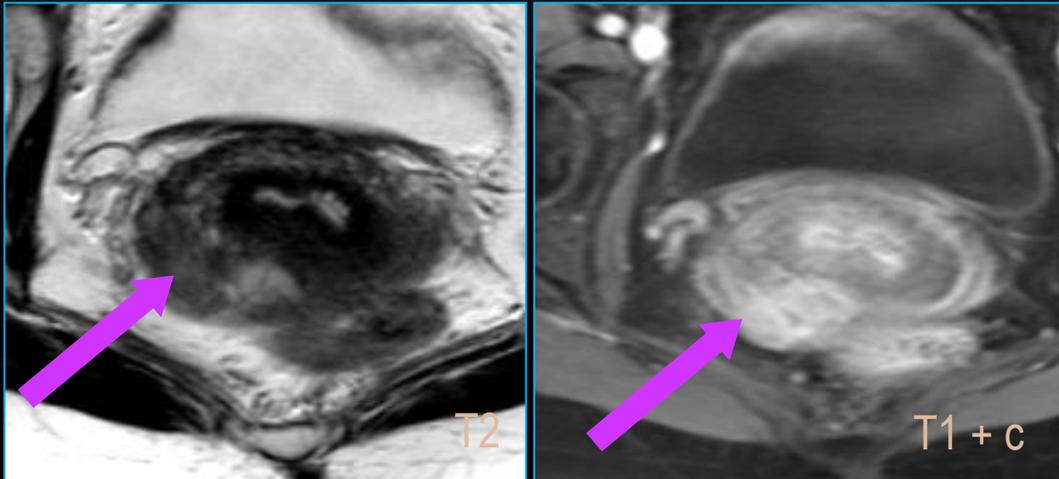
Post chemoradiation:

Soft tissue stranding in the cervix, radiation vs. recurrent tumor. PET/CT shortly after demonstrates no corresponding FDG activity, consistent with treatment changes (arrows). Please note brachytherapy seeds.

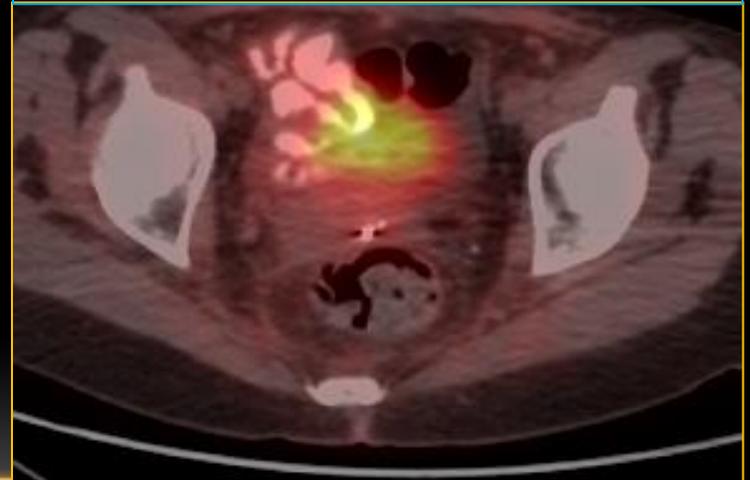


PITFALLS

False positive parametrial extension



Top images: T2 hyperintense, enhancing mass involving the right posterolateral cervix (arrows). Bottom images: Post-radiation, hazy soft tissue in the same region, equivocal for residual tumor versus radiation change (arrows).



PET-CT performed shortly after demonstrates no residual tumor.

PITFALLS

Importance of intact cervical stroma post treatment



Cervical tumor (T) in the posterior wall of the exocervix with loss of the adjacent cervical stroma (arrow).

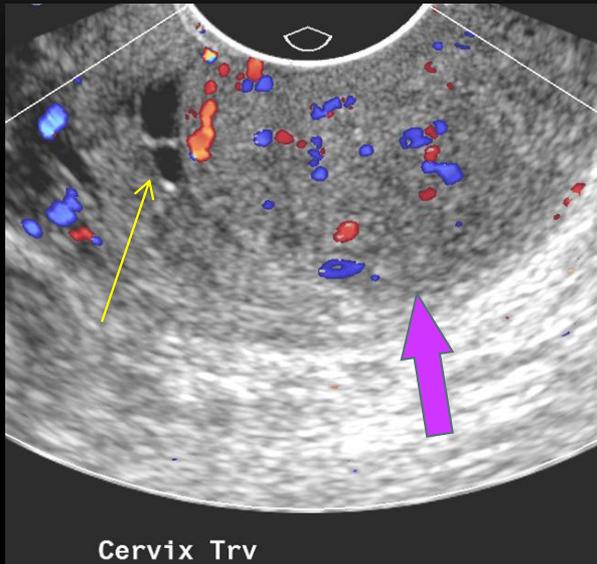


Good treatment response after radiation, now with visualization of the T2 hypointense cervical stroma (arrow).

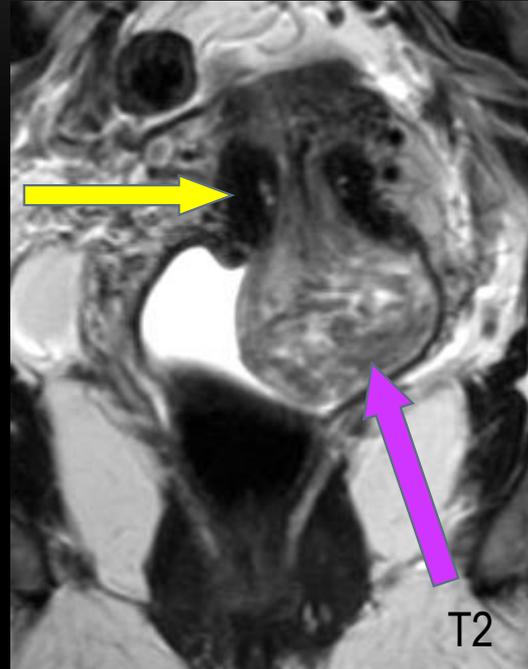
Pitfall: "Burned out" endometriosis along the posterior vaginal fornix which was mistaken for residual tumor post-treatment and seen in retrospect on the initial image (arrows).

PITFALLS

Alternate Diagnoses



Large vascular mass centered in the cervix on the initial ultrasound (purple arrow). Please note displaced nabothian cysts (thin yellow arrow).



Coronal T2 image demonstrates a large hyperintense mass in the cervical canal (purple arrow). However, note intact cervical stroma (yellow arrow).

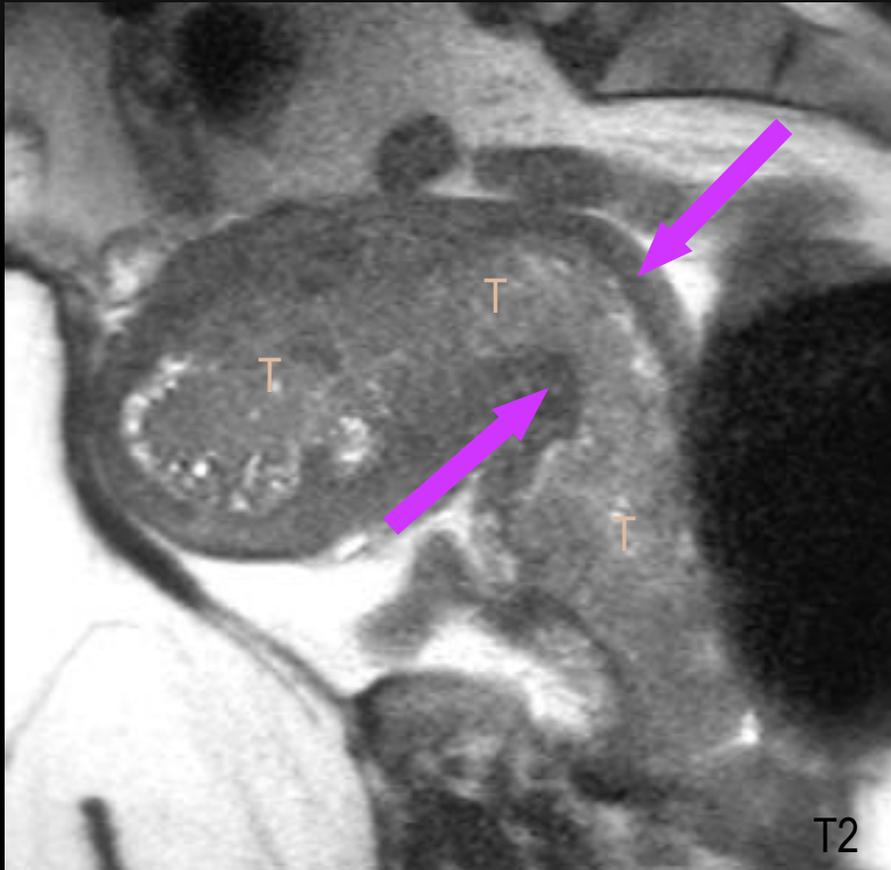


Sagittal T2 demonstrates a polypoid mass originating from the junctional zone (purple arrow) protruding into the cervix.

Pathology proven polypoid adenomyoma.

PITFALLS

UNUSUAL APPEARANCE OF CERVICAL CANCER



Adenocarcinoma of the cervix. Large mass centered in the endometrial cavity (T) extending into the vagina, initially concerning for endometrial carcinoma. Please note the preserved cervical stroma (arrows).

Pathology results showed adenocarcinoma strongly associated with markers indicative of HPV related tumor and therefore adenocarcinoma of the cervix was favored.

TAKE HOME POINTS:

- ✓ Although FIGO does not require MRI in the staging of cervical cancer, imaging is now recommended to supplement clinical assessment, often replacing cystoscopy and proctoscopy.
- ✓ MRI is the imaging modality of choice for staging primary cervical tumor, evaluating response to treatment and detecting tumor recurrence and potential complications.
- ✓ High resolution T2-weighted imaging is the mainstay for tumor detection with post contrast T1 and DWI serving important complementary roles.
- ✓ T2 hypointense intact cervical stroma is a critical finding when staging cervical cancer and assessing treatment response.
- ✓ Three factors that most accurately correlate with disease-free survival are lymphatic involvement, tumor size, and depth of stromal invasion.
- ✓ PET/CT can often help in evaluating equivocal findings on post-treatment cervical MRI.

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