Abdominal Radical Trachelectomy (ART) with MRI guidance:
A state-of-the ART approach

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Learning objectives

To learn the findings and limitations of dedicated pelvic MRI in selecting young patients with early-stage cervical cancer to be treated with abdominal radical trachelectomy (ART).

To describe ART procedure and compare it with vaginal radical trachelectomy (VRT).

To become familiar with the normal post-ART MR appearance of the uterus and the potential complications of the procedure.

Background

Invasive cervical carcinoma largely affects women of reproductive age [1]. During the last decades, as more women delay childbearing [2], there is a considerable number of young patients with cervical cancer who want to preserve their uterus [3]. Radical trachelectomy via an abdominal (ART) or vaginal (VRT) approach is a surgical procedure which may allow young patients to preserve their reproductive potential. Such fertility-preserving surgical options must be curative without compromising overall survival, so the candidates must be carefully selected [4].

In ART the cervix, both parametria (medial portions of the cardinal and uterosacral ligaments) and the upper 1-2cm of the vagina are excised through an abdominal approach. The uterine isthmus is then anastomosed to the vaginal cuff and in most cases a permanent cerclage suture is positioned at the anastomotic site, in order to support future pregnancy. Routinely, pelvic lymphadenectomy is performed in all patients, while in case of large tumors, concomitant paraaortic nodal sampling is also recommended.

The main advantage of ART compared to VRT, is the more extensive resection of parametrial tissue, similar to that of abdominal radical hysterectomy and the more precise selection of the anastomotic site [5, 6, 7]. ART is preferred for patients with large exophytic masses (2-4 cm), clear cell histology, distorted cervicovaginal anatomy due to prior conization, pregnant patients in the first trimester and pediatric patients. ART appears to have comparable outcome with VRT and lower intraoperative complication rates [8].
Eligibility criteria for radical trachelectomy are of critical importance, since rates of recurrence depend upon selection of candidates [5]. Ideally, patients with < IB1 tumors and superficial invasion are the most suitable candidates.

Adverse prognostic factors for successful treatment include tumor size >2cm (or >4cm, for some authors), age >40 years, extensive lymphovascular invasion (LVSI) and non-squamous histology. More than 1cm distance (or >5mm, for ART cases) between upper margin of tumor and uterine isthmus is required for fertility-preserving surgery [6,7].

Underestimation of tumor size and extensive endocervical tumor are common reasons for abandoning trachelectomy intraoperatively (17%). Both are reliably assessed with preoperative MRI [9].

MRI, although not included in the official FIGO staging system, mainly for socioeconomic reasons, is the appropriate imaging modality for assessing tumor size, endocervical extension, extrauterine spread and nodal status, aiming to reduce the number of intra-operatively aborted ART procedures.

MRI may also be applied to the follow-up of post-trachelectomy patients to detect potential recurrence or complications, some of which may compromise the ability of patients to conceive.

**Findings and procedure details**

MRI can accurately estimate maximal tumor diameter, coming within 5mm from that of the resected specimen in 70-90% of cases [10].

Detection of small (< 1cm) superficial tumors may be difficult; dynamic-contrast enhanced (DCE) MRI or diffusion weighted images (DWI) may be of value in such cases, especially with the use of special endocavitary coils [11].

Tumor size can be underestimated in tumors with circumferential growth pattern, on poor quality MR-images (due to bowel peristalsis or body habitus) and in cases of limited experience in pelvic MR imaging. False positive results may occur due to post-biopsy inflammation; DWI may aid diagnosis, since inflammation shows no molecular restriction in contrast to cancerous tissue [11] (Fig. 1).

MRI can correctly assess endocervical extent and tumor-internal os distance in most cases [12]. Extension of tumor beyond the internal os and myometrial invasion, apart from excluding trachelectomy due to lack of tumor free margins, is also an adverse prognostic
factor, since it increases the probability of nodal metastases from 11% to 75% [13]. MRI is highly sensitive (100%) and specific (96%) in predicting extension of tumor to the internal cervical os [14,15]. Caution is required with coexisting lesions, such as adenomyosis, endocervical polyps or multiple Nabothian cysts, which may lead to false positive results (Fig. 2). On the contrary, false negative results may occur due to microscopic tumor infiltration.

Overall MRI accuracy for parametrial evaluation ranges from 88-97% [16]. MRI has a high negative predictive value for parametrial invasion (94%), so it is a reliable tool in identifying suitable candidates for radical surgery. Also, MRI is highly sensitive for vaginal wall integrity (86-93%) [17,18].

MRI sensitivity for lymph node detection is low (43-73%) [18]. Lymph node characterization is based on size criteria, with a short axis >1cm considered abnormal, but there is a significant overlap between malignant and inflammatory nodes. Depiction of microscopic nodal infiltration is difficult, even with functional imaging techniques. Necrotic foci within a node are indicative of malignant infiltration, but they are uncommonly seen (Fig. 3).

Interestingly, most nodal metastases are detected during trachelectomy, at frozen section examination, and, even then, 36% remain undetected [9].

The proposed ESUR MR study protocol for cervical cancer staging includes only T2- and T1-weighted sequences [19]. Dynamic contrast-enhanced and DW images are used for assessment of small tumors, equivocal T2 findings or post-treatment evaluation; in our experience, both sequences may increase the diagnostic accuracy of MRI, particularly in selecting candidates for trachelectomy. In pregnant patients, where there is little experience for the safe use of paramagnetic contrast media, DWI can be quite helpful in depicting tumor margins (Fig. 4,5).

MRI may be used for the follow-up of patients after trachelectomy, since clinical evaluation of the uterovaginal anastomosis is difficult. Radiologists should be familiar with post-trachelectomy changes. Typical MRI findings after trachelectomy include: a fold of the posterior vaginal wall (neo-fornix), diffuse vaginal wall edema persisting for over 1 year and slowly-resolving vaginal wall hematomas (Fig. 6). Artifacts caused by the anastomotic suture in a few cases may, rarely, pose a problem [20] (Fig. 7).

Usual post-ART complications include pelvic lymphocysts or stenosis at the anastomosis, both of which are readily detected with MRI [20].
To our knowledge, hydrosalpinge is an uncommon complication of ART, which is not observed with VRT. It should be recorded since it may influence the reproductive potential of trachelectomy patients (Fig. 8,9).

Recurrence rate in patients treated with ART is less than 5% [8]. MRI can readily detect local tumor relapse (Fig. 10), lymph node enlargement (Fig. 3) or distant metastases.

Images for this section:
Fig. 1: A 29-year-old patient with early cervical cancer, candidate for ART. Sagittal DCE-MR image in early arterial phase shows a strongly enhancing focus in the external cervical os, suspicious for residual tumor (white arrow). DWI (not shown) did not show molecular restriction. Histopathologic examination revealed post-biopsy inflammation but no cancer. Note the distended - with sterilized gel - vagina (asterisk).
Fig. 2: A 39-year-old nulliparous woman with a biopsy confirmed cervical adenocarcinoma. Sagittal DCE-MR image, delayed phase, shows abnormal signal...
intensity of uterine endometrium and adjacent myometrium (long white arrow). A small enhancing lesion is also detected in the internal cervical os (small white arrow), which was interpreted as malignancy. Pre-operative hysteroscopy showed adenomyosis and a dysplastic endocervical polyp, respectively. The patient was finally treated with ART. No residual tumor was found in final surgicopathological examination.

**Fig. 3:** Follow-up MRI of a 29-year-old ART patient, one year after trachelectomy. Axial T2-W image shows an enlarged left common iliac node (black arrow), with a central area of high signal intensity, consistent with necrosis. PET-CT (not shown) revealed high metabolic activity of the node (SUV=18). The patient was treated with a combination of chemotherapy and radiotherapy of the pelvic and paraaortic area.
Fig. 4: A 29-year-old patient with adenosquamous cervical cancer in the 7th week of gestation, candidate for ART. Sagittal DWI (b-value 1000) shows clearly an hyperintense lesion (restricted diffusion) extending into the cervical canal (white arrow). Intrauterine gestational sac is also noted.
Fig. 5: Sagittal T2-W image of the same patient as in Figure 4 shows less clearly the cancerous lesion (white arrows).
Fig. 6: Post-ART appearance. Cervicovaginal anastomosis is easily identified on sagittal T2-W image (white arrow), even in a retroflexed uterus. The low signal intensity structure at the anastomosis, is consistent with the cerclage suture which is placed to support future pregnancy. Persistent vaginal wall edema is also noted (asterisk), six months after ART.
**Fig. 7:** Cerclage suture artifact. Sagittal DCE-MR image of the same patient as in Figure 6, shows susceptibility artifact in the region of the anastomosis, which degrades image quality (white arrow). Metallic cerclage suture may cause susceptibility artifact mostly on gradient echo sequences.
Fig. 8: Post-ART complications. A 35-year-old patient, three years after ART, presented with prolonged menstruation and infertility. Axial T2-W image shows a high signal intensity tubular structure next to the left ovary (black arrows), consistent with a dilated left fallopian tube. Note the enlarged endometrial cavity, with haemorrhagic content (small black arrows), due to isthmic stenosis.
Fig. 9: Post-ART complications. Sagittal T1-W fat-suppressed contrast-enhanced image of the same patient as in Figure 8 confirms the presence of a dilated left hydposalpinx with enhancing wall (black arrows).
Fig. 10: Tumor relapse, one year post-ART. T2-W image shows a large soft tissue mass extending from the anastomosis to the lower vagina (black arrows). Biopsy revealed recurrence. The patient was treated with brachytherapy and external radiation therapy, with poor results.
Conclusion

Dedicated pelvic MRI is a useful tool for the pre- and postsurgical evaluation of ART patients. Radiologists should be aware of potential pitfalls to avoid misdiagnosis. Post-ART complications such as hydrosalpinx should be carefully looked for, since they may influence fertility potential. Radiologists with experience on gynecological imaging should work together with the gynecologic-oncologists to provide optimal care for young patients with early-stage cervical cancer.

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References


