

Preoperative imaging in patients undergoing trachelectomy for cervical cancer: validation of endovaginal T2- with diffusion-weighted MRI at 3.0T

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Target Audience: Radiologists, physicists with interest in gynaecological MR or clinical applications of DWI in oncology

Purpose: In women with cervical cancer being considered for fertility sparing surgery, the volume and degree of endocervical extension is of major importance when planning radical vaginal trachelectomy¹. For tumors <1cm, endovaginal T2-W MRI at 1.5T has been shown to be more sensitive² with the addition of diffusion-weighted techniques further improving diagnostic accuracy^{3,4}. The purpose of this study therefore was to compare MRI derived measurements of tumor size/ volume and length of uninvolved endocervical canal on T2-W images viewed in conjunction with diffusion weighted sequences acquired using an endovaginal technique at 3.0T with measurements made on trachelectomy specimens in order to establish the validity of the preoperative assessment.

Methods: Research ethics committee approval and patient written informed consent were obtained. 55 consecutive patients 25-44 yrs (mean 30.5 ± 4.9 yrs) with stage I cervical cancer being considered for fertility-sparing surgery were prospectively assessed with endovaginal MRI. T2-W images (TR/TE = 4500/80 msec, FOV 100mm, section thickness 2 mm, no gap) were obtained in three orthogonal planes to the cervix (0.42 mm in-plane resolution, 0.36mm³ voxel size, 0.25mm³ reconstructed). Zonal Oblique Multi-slice (Zoom) diffusion-weighted (DW) echo-planar images (TR/TE 6500/90, FOV 100mm, b values 0, 100, 300, 500, and 800 sec/mm² in three planes matched the T2-W images. In plane resolution 1.25mm, voxel size 3.15mm³, 0.41mm³ reconstructed). Twenty four 2mm thick sections covered the cervix (acquisition time 4min 33sec). Isotropic ADC maps were generated using all b values. 2 independent observers on separate occasions with reference to the b-800 DWI and ADC map recorded maximum tumor dimension, tumor volume (drawing regions of interest [ROIs] around the tumor and multiplying the summed ROI area by slice thickness). The distance from the superior aspect of the tumor to the internal os was recorded on the sagittal T2-W images with reference to the corresponding ADC map. Measurements were made blinded to histology. Tumor volumes were calculated on trachelectomy histopathology specimens: slides that contained tumor outlined by a pathologist were scanned or photographed at high resolution with a set scale (Nikon D100) and the area of the tumor ROI (in mm²) on each slice was multiplied by the slide interval (4 mm). The distance from the superior aspect of the tumor to the proximal resection margin (usually distal to the internal os) was also measured.

Results: 25 patients had radical trachelectomy, 19 had extended cone biopsy, 1 had a LLETZ, 3 had hysterectomy and 7 chemoradiotherapy. Of 45 patients that underwent fertility-sparing surgery, 15 had residual tumor (14 at trachelectomy and 1 on cone biopsy). Of these, 2 had no visible tumor on MRI and tumor volume was recorded as zero. Six patients had tumor recorded at MRI, but were negative on histology. Sensitivity and specificity for detecting tumor in the cohort treated with fertility sparing surgery was 86.7% and 80.0% respectively (PPV 68.4%, NPV 92.3%).

Maximum tumor dimensions, volumes and distance from the endocervical canal are given in Tables 1, 2 and 3 respectively. In the 13TP, 2FN and 6FP cases (n=21), Pearson's correlation coefficient for maximum dimension and volume of lesion between observers was 0.92 and 0.8 respectively ($p < 0.0001$). Correlation between MRI and histology for dimension and volume was 0.80 and 0.79 (Obs 1) and 0.86 and 0.52 (Obs 2) ($p = <0.005$ and 0.015 respectively). The ratio between MRI and histology measurements for length of uninvolved endocervical canal above tumor was 1.7 ± 1.1 (Obs 1), 1.7 ± 1.3 (Obs 2). In 1/19 cases (5%) the ratio =0.6 for both observers (being >0.7 in the other 18), indicating that MRI had substantially underestimated the available length of normal endocervical canal superior to the tumor in this case.

Table 1: Tumor dimension comparison with histology (n=15, 13TP, 2FN)

	Size Obs 1	Size Obs 2	Histology
Mean \pm SD [mm]	12.4 ± 9.8	14.2 ± 8.4	11.2 ± 7.7
Median (IQR) [mm]	11.0 (5.5-17.0)	14.0 (10.5-19.8)	10.0 (6.1-14.8)
Range [mm]	0-38	0-22	0-30

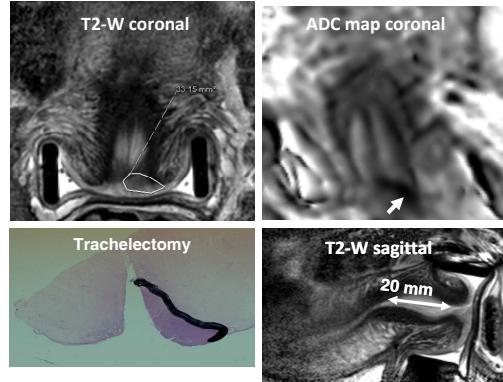
T2-W images showing a small tumor confined to the cervix with endocervical extension. Corresponding ADC map shows the tumor as a focus of restricted diffusion. A 2cm clearance from the superior aspect of the tumor to the internal os made this patient a candidate for trachelectomy.

Table 2: Tumor volumetry comparison to histology (n=12)

	Vol Obs 1	Vol Obs 2	Histology
Mean \pm SD [cm ³]	0.75 ± 0.72	0.97 ± 1.3	0.71 ± 0.69
Median (IQR) [cm ³]	0.5 (0.3-1.2)	0.35 (0.13-1.04)	0.31 (0.23-1.16)
Range [cm ³]	0-1.7	0-4.4	0.012-2.0

Table 3: Distance to internal os comparison with histology (n=19, 12TP, 2FN, 5 FP)

	Dist tum to os Obs 1	Dist tum to os Obs 2	Dist tum to resection margin (Histo)
Mean \pm SD [mm]	19.0 ± 5.7	18.9 ± 5.6	15.5 ± 8.5
Median (IQR) [mm]	20.0 (15.5-22.0)	19.6 (17.1-21.6)	17.5 (6.5-21.0)
Range [mm ³]	8-32	6-27	5.0-34.0



Discussion and Conclusion: Endovaginal T2-W + ZOOM DWI shows good correlation of tumor size, volume and estimation of available length of normal endocervical canal superior to the tumor with subsequent histology in patients with cervical cancer referred for fertility-sparing surgery. Preoperative endovaginal MRI is invaluable in selecting candidates for fertility sparing treatment because the overall oncological outcome of trachelectomy when used appropriately is equal to radical hysterectomy.

References: [1] Shepherd JH. Best Pract Res Clin Obstet Gynaecol 2012; [2] deSouza NM et al J Magn Reson Imaging 2000; [3] deSouza et al Gynecol Oncol 2006; [4] Charles-Edwards et al Radiology 2011

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