Clinical utility of endovaginal MRI at 3T with a Zonal Oblique Multislice (Zoom) Diffusion-Weighted technique for selecting patients with carcinoma of the cervix for fertility sparing surgery

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Target audience: Radiologists, physicists and surgeons with an interest in gynaecological imaging and Radiologists, physicists and other scientists with an interest in diffusion weighted imaging and endocavitary techniques.

Purpose: With the implementation of screening, the presentation of carcinoma of the cervix is often with early stage, small volume disease. This offers the potential for fertility-sparing procedures such as trachelectomy (excision of the cervix with vagino-isthmic anastomosis) [1]. Accurate depiction of tumor margins preoperatively in relation to normal cervical anatomy is crucial in selecting patients for this technique. The use of an endovaginal receiver coil has previously shown an improvement in the detection of small tumors, particularly when T2-weighted (T2-W) contrast is supplemented with diffusion-weighted (DW) contrast. [2] However, at 3T, an EPI-DW sequence suffers from disabling artefact (B1 inhomogeneity) when an endovaginal receiver coil is present, leading to image distortion. An alternative technique for generating DW contrast is the Zonal Oblique Multislice (Zoom)-EPI sequence that reduces distortion and improves resolution by reducing the field of view (rFOV). [3] The purpose of this study was to determine the sensitivity and specificity of T2-W + Zoom-DW imaging using an endovaginal coil at 3T for detecting cervical cancer, compare the tumor:stromal contrast on T2-W with that on diffusion-weighted imaging (DWI) and document the impact of the technique on surgical management.

Method: 57 patients with stage I cervical cancer had endovaginal MRI imaging at 3T after diagnostic cone biopsy. 31 of these were being considered for trachelectomy. T2-W images (TR/TE = 4500/80msec) were obtained in three orthogonal planes to the cervix [sagittal, coronal and transverse]. Zoom-DWI (TR/TE 6500/90msec) with b-values of 0, 100, 300, 500, and 800sec/mm^2 were obtained to match the T2-W images. ADC maps were generated using all b-values. *Tumor detection:* T2W + Zoom-DWI images were assessed in combination for presence of tumor by 2 separate observers blinded to the details of previous histopathology. Where tumor was identified, maximum tumor dimensions and the distance from the superior aspect of the tumor to the internal os was recorded by each observer. These measurements were correlated with similar measurements recorded on the pathological specimen from trachelectomy (n=9). *Contrast measurements:* In patients with identifiable tumor, tumor contrast normalized to the cervix ($(S_1 - S_2)/S_2$) was calculated from regions of interest (ROIs) within tumor (S_1 = tumor signal intensity) and adjacent normal cervix (S_2 = normal cervix signal intensity) on a single sagittal or coronal slice of T2-W and corresponding b-800-DW image. *Decision for trachelectomy*: In patients referred for fertility sparing surgery review at the tumor board meeting decided subsequent management on clinical and imaging grounds between trachelectomy vs. more or less radical treatment options.

Results: *Tumor detection:* Sensitivity and specificity was 91.7% and 78.3% (Ob1) and 83.3% and 69.6% (Ob2) with PPV and NPV of 81.5% and 90.0% (Ob1) and 74.1% and 80.0% (Ob2). Inter-observer agreement was good (kappa =0.63). The mean volume of the lesions in the false positive cases was 0.07cm^3 (Ob1) and 0.2cm^3 (Ob2) compared to a volume of 3.8cm^3 (Ob1) and 3.9cm^3 (Ob2) in the true positive group. When tumours <0.5cm^3 (n = 7) were omitted from the analysis, the specificity improved to 100% for both observers and there was complete agreement (kappa = 1). *Contrast measurements:* In patients with identifiable tumor (n=27) mean tumour contrast was 1.31 for T2-W and 4.69 for DW-MR images and was significantly higher in the latter (p=<0.005). *Decision for trachelectomy:* In the subgroup of 31 patients recruited for consideration of fertility sparing surgery, endovaginal MRI enabled less radical surgery than trachalectomy in 53% (extended cone biopsy) and dictated the use of more radical treatment than trachelectomy in 29% of cases (radical hysterectomy or chemoradiotherapy). The maximum dimensions of the tumour on MRI correlated well with histology (Pearson's correlation coefficient was 0.91 (Ob 1) and 0.95 (Ob 2). p = <0.005). The correlation between the distance from the proximal aspect of the tumour to the internal os on imaging and histology was not significant (r=0.47 (Ob 1) and 0.42 (Ob 2) p = 0.29 and 0.34 respectively).

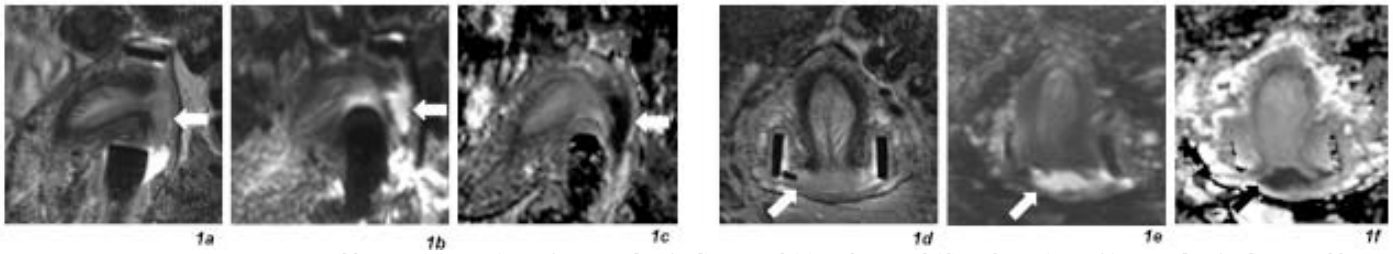

Figure 1. Stage 1 tumor in a 38 year old patient: T2-W (3119/80 msec [TR/TE]) sagittal (a) and coronal (d) and DW (7396/52 msec [TR/TE[) sagittal b-800 (b) and corresponding ADC map (c) and coronal b-800 (e) and corresponding ADC map (f) images through the cervix show a tumor on the posterior lip (arrows). Superior tumor contrast on the b-800 images in comparison to the T2-W images is noted.

Discussion and Conclusion: Our results at 3T show an improved sensitivity and specificity for detection of tumor when using T2-W in conjunction with Zoom-DWI in comparison to data collected at 1.5T [2]. The addition of Zoom diffusion sequences greatly improves contrast resolution compared to T2-W images but the presence of susceptibility artefacts post biopsy continue to be a problem especially with tumors that are < 5mm in maximum dimensions or less than 0.5cm^3 in volume. Correlation between the size of the tumor at MRI compared to that at histological evaluation is excellent. Results were more disappointing when correlating distance between the proximal aspect of the tumor and the internal os. This may have been due to specimen shrinkage (MRI overestimated the distances in the majority of cases) as a result of formalin fixation or internal os inclusion/exclusion on histological specimens. The use of endovaginal imaging at 3T with T2-W and Zoom-DW MR sequences is invaluable for stratifying patients referred for fertility sparing surgery towards more or less radical treatment.

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