Faster MR imaging of cervical and endometrial carcinoma through a limited sequence protocol based on high-resolution, free-breathing, post-contrast 3D SPGR imaging with comparison to standard care

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Target Audience: Clinicians utilizing MRI to evaluate cervical and endometrial carcinoma. Researchers interested in free-breathing, post-contrast imaging in the pelvis.

Purpose: Standard MRI protocols for cervical and endometrial carcinoma include three oblique planes of T2-weighted fast spin echo (FSE) images, with many institutions also performing diffusion-weighted and multiplanar post-contrast T1 weighted imaging [1]. The T2 imaging alone requires more than 20 minutes of scan time with an average study requiring at least 30-40 minutes. In our clinical practice, referring gynecologic oncologists and patients expect staging studies to be scheduled within two days of the request, which is challenging and limits the use of MRI. Thus, we investigate whether MR imaging can be accomplished utilizing a streamlined 10-minute protocol consisting of a single plane of T2 with fat saturation and a single high-resolution, free-breathing post-contrast 3D SPGR sequence.

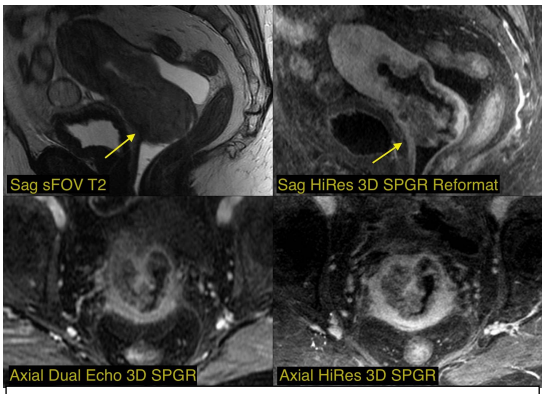

Fig 1: Representative sequences showing an expansile, infiltrative, partially necrotic enhancing mass centered within the cervix (arrow). The high-resolution 3D SPGR sequence was acquired in a delayed phase when tumor may be delineated by its washout from surrounding normal stroma.

Methods: *Subjects and Protocol*: We retrospectively identified with IRB approval 19 patients referred with either cervical carcinoma or suspected endometrial malignancy (8 cervical squamous cell carcinoma, 1 cervical adenocarcinoma, 8 endometrial adenocarcinoma, 1 leiomyosarcoma, and 1 endometrial hyperplasia) referred for 3 Tesla initial staging over an 11-month period that included specific sequences (Table 1). A phased array torso coil was used, along with intramuscular glucagon. Field-of-view was adjusted to patient anatomy except for small FOV T2 sequences that were set to 22-cm. The high-resolution, axial, free-breathing 3D SPGR sequence was modified to acquire Cartesian k-space data with a radial ordering to disperse respiratory artifacts [2], utilized an intermittent spectrally selective inversion recovery fat suppression, was acquired at 1.2-mm slice spacing interpolated to 0.6 mm, and had a scan time of 4-5 min.

Conventional Bundle		Fast Bundle	
Axial fat suppressed T2	416 x 224 TE 100	Axial fat suppressed T2	416 x 224 TE 100
Sagittal small FOV T2	512 x 320 4 mm slices 22 cm FOV TE 120	High-res post-contrast 3D SPGR	416 x 416 1.2 mm slices 30-44 cm FOV
Ax Oblique small FOV T2		Reformat to Obliques: Axial, Sagittal, Coronal	
Cor Oblique small FOV T2			
Axial multiphase 3D Dual Echo SPGR	320 x 224 3 mm slices Breath-held 6 phases		
Scan time ~30 minutes		Scan time ~10 minutes	

Table 1: "Conventional" vs. "fast" bundles.

Image scoring and analysis: Each exam was separated into a "conventional" bundle consisting of all T2 sequences and pre/post-contrast dual echo 3D SPGR (LAVA-Flex) sequences, and a "fast" bundle consisting only of axial T2 FS and the high-resolution 3D SPGR sequence that was reformatted to axial/coronal/sagittal obliques. Two readers evaluated either the conventional bundle or fast bundle for each patient in an alternating manner. Readers recorded imaging findings relevant to staging of cervical or endometrial carcinoma and assigned a confidence score between 1 (poor) and 4 (high) for each finding. Discrepancies in staging between the two bundles were resolved by surgical pathology or documented clinical staging for treatment by gynecologic oncology. The null hypothesis of no significant difference in presence of imaging findings and confidence scores was assessed using a Bonferroni-corrected Wilcoxon signed rank test for confidence scores and a McNemar test for binomial parameters with a target alpha of 0.05.

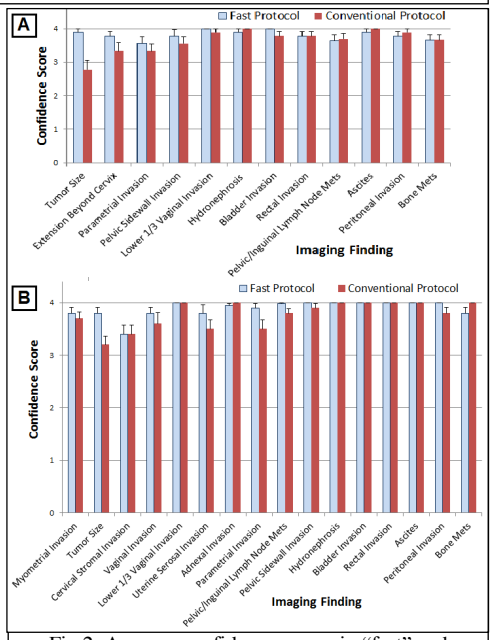

Fig 2: Average confidence scores in "fast" and "conventional" bundles for imaging findings relevant to (A) cervical carcinoma and (B) endometrial carcinoma staging. Error bars denote standard error of the mean.

Results/Discussion: Examples of image quality are shown in Fig 1. No imaging findings demonstrated any significant difference between the "conventional" and "fast" bundles. Confidence scores were also not significantly different (Fig 2). Out of 5 discrepancies in cervical cancer staging between the two bundles, the "conventional" and "fast" bundles each matched the final staging in 2 patients. In 1 patient, both bundles did not match the final staging; however the "fast" bundle was closer. Out of 4 discrepancies in endometrial cancer staging, the "conventional" and "fast" bundles each matched the final staging in 1 patient. Both bundles did not match the final staging in 2 patients; the "conventional" bundle was closer to the final staging in 1 patient and the "fast" bundle closer in the other patient.

Conclusion: In this small sample, a fast protocol including a high-resolution, post-contrast 3D SPGR sequence did not result in significantly different staging or confidence scores compared to a conventional protocol, and can greatly reduce total scan time from 30-40 min to ~10 min. This should increase patient satisfaction, and may increase access to MRI in settings with constrained MR capacity. Ongoing work is directed towards confirmation in a larger patient cohort.

References:

[1] Freeman SJ, Aly AM, et al. The revised FIGO staging system for uterine malignancies: implications for MR imaging. *Radiographics*. 2012 Oct;32(6):1805-27.
[2] Cheng JY, Zhang T, et al. Free-breathing pediatric MRI with nonrigid motion correction and acceleration. *JMRI*. 2014 Oct 20. doi: 10.1002/jmri.24785.