

### 3T High-field MRI with ultra-high spatial resolution

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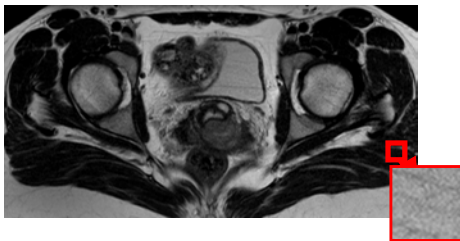
**Introduction:** The increase in signal-to-noise (SNR) at 3 Tesla offers the possibility to either increase spatial or temporal resolution without sacrificing an acceptable imaging time. Any increase in spatial resolution will improve the detection of small anatomic details which in turn may have an impact on diagnostic confidence. The purpose of this study was first to develop a 3T pulse sequence with ultra-high spatial resolution in acceptable scan time and second to compare the images with those obtained with a 1.5 T routine protocol.

We analyzed image contrast of normal anatomy and of frequent pathologic pelvic disorders at 3T and compared those images with the routine 1.5T protocol.

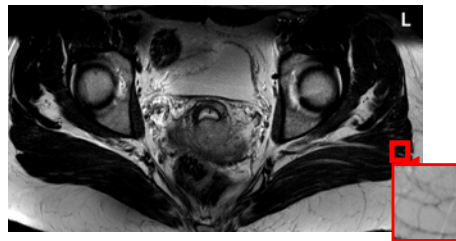
**Material and methods:** We performed a prospective intraindividual comparative trial on 16 patients who underwent MRI of the pelvis twice, once at 1.5T and within 3 days again at 3T. The patients presented with cervical cancer, uterine myomas and ovarian cancers. Using our routine 1.5T protocol (T2-weighted TSE-sequence) as a standard of reference (TR/TE 2705ms/80ms; 0.74 x 0.74 x 4mm voxel size; FOV 360 mm; 4.19 min scan time; CLEAR; Philips Gyroscan Intera 1.5 T, Philips Medical Systems, Best, The Netherlands), we designed a 3 Tesla ultra-high resolution pulse sequence protocol (TR/TE 3958ms /70ms; 0.35 x 0.35 x 4mm voxel size; FOV 360 mm; 8.18 min scan time; SENSE; Philips Gyroscan Intera 3T, Philips Medical Systems, Best, The Netherlands). In order to keep the examination time acceptable for patients (higher matrix, SAR limitations) we combined this protocol with SENSE (sf 3) and flip angle sweep (130°), resulting in a total acquisition time of 8:18 min. Accordingly, while the spatial resolution was four times as high as at 1.5T, the acquisition time was “only” doubled. In order to reduce peristalsis, iv N-Butylscopolamine was given to all patients prior to the study. In consensus, two radiologists analyzed the examinations with regard to overall image quality (rated subjectively on a 3 point scale with 3 = 3T superior; 2 = 3T equal; 1 = 3T inferior compared to 1.5T), image artifacts (rated on a five point scale: 1 = no artifacts; 2 = minimal; 3 = moderate, not diagnostically relevant; 4 = poor image quality; 5 = non-diagnostic study), image contrast (visualization of uterine zonal anatomy, delineation of pathologic findings; rated on a 3 point scale with 3 = 3T superior; 2 = 3T equal; 1 = 3T inferior compared to 1.5T). As the CLEAR and SENSE technologies interfere with the calculation of the background noise, we measured the signal difference between muscle and bone marrow, as a surrogate marker for image contrast.

**Results:** 3T MRI pelvic studies were technically successful in 16/16 patients. 15/16 examinations at 3Tesla were of diagnostic image quality: subjective image quality was assessed equivalent to 1.5 T in 15/16 examinations. Only minor artifacts were observed with 3T imaging in 15/16 patients. Artifacts due to ghosting were rated 2,23 +/- 0,73 (range 1-4) at 3T as compared to 2,23 +/- 0,73 (range 1-3) at 1.5 T. Poor image quality was observed in 1/16 pelvic MRI study at 3T due to ghosting. With regards to image contrast: qualitative analysis revealed comparable image contrast in 14/16 pelvic MRI studies, and better image contrast for 1.5T in 2/16 pelvic MRI studies. The quantitative analysis revealed a tendency towards reduced image contrast at 3T (0,38 +/-0,11) as compared to 1.5T (0,52 +/-0,15). Upon clinical film reading, the degree of anatomic and pathologic detail that was provided by the high resolution 3T study was rated consistently and substantially higher compared to the details visible in the 1.5T standard protocol. Consequently image quality at 3T was rated superior as compared to 1.5T for all 16/16 pelvic MRI studies. In our small series however, the delineation of pathologic findings was rated equivalent.

**Figure 1 a:** Carcinoma of the cervix FIGO IIB at 1.5T



**Figure 1b:** Carcinoma of the cervix FIGO IIB at 3T



**Conclusion:** High spatial resolution pelvic studies with high image quality can be obtained on a 3 Tesla system in an acceptable acquisition time. Whether or not this also translates into clinically relevant additional diagnostic information remains to be seen, and is subject to an ongoing study.