Three-dimensional 1H-magnetic resonance spectroscopic imaging of the prostate peripheral zone in clinical practice

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Background and goals

During the last decade, three-dimensional ^{1}H-magnetic resonance spectroscopic imaging (MRSI) of the prostate has been shown to improve the sensitivity and specificity of cancer diagnosis based on MRI and has consequently been proposed as a first line diagnostic procedure (1,2). In this study, our goals were to implement such a technique in a clinical MR routine setting, describe our early experience in the study of the peripheral zone of patients referred for clinical MRI examination and evaluate the results based on biopsy data.

Methods

MR imaging and spectroscopic imaging were performed on 45 consecutive patients referred to our institution for examination. Data were acquired on a Signa 1.5 Tesla LX. system with Excite II (GE Healthcare, Milwaukee, WI) using the body coil for RF transmission and a combination of a pelvic phased-array coil (Torso PA; GE Medical Systems) with a commercially available balloon-covered endorectal coil (Endo ATD; Medrad, Pittsburgh, Pa) for signal reception. Proton spectra were collected throughout the prostate's entire volume using the manufacturer supplied PROSE sequence (PRESS volume selection with fat and water saturation; 1000/130 ms; studied volume, 110 x 55 x 55 mm; matrix, 16 x 8 x 8 resulting in 1024 voxels with spatial resolution of 0.32 cm3; scan time, 17 minutes). Spectral data were aligned with axial T2-weighted multiple spin echo images (4740/82.3 ms; echo train length, 16; field of view, 14 cm; section thickness, 3 mm; no section gap; number of acquisitions, 4) using Functool-2 (GE Healthcare, Waukesha, WI) and spectra automatically post-processed and reconstructed with such commercial software. Voxels suspicious for cancer in the peripheral zone were defined as Choline+Creatine / Citrate ratio (CC/Ci) greater than 0.86 as reported by Kurhanewicz.et al (1). The study population consisted of patients with biopsy-proven prostate cancer (n=26, 9 bilateral and 17 unilateral) and patients with elevated PSA levels or abnormal digital rectal examination and who had not previously undergone biopsy or whose biopsies had resulted negative (n=19). Histology of transrectal ultrasound-guided sextant biopsy was used as the standard of reference.

Results

MRSI was positive for cancer in 25 patients with proven prostate cancer. The only false negative result was in a patient with unilateral disease due to a recent post-biopsy hemorrhage, as assessed in T1-weighted images, and which resulted in degradation of the MRS signal. In 8 of the 9 patients with bilateral cancer, there was agreement of MRSI results with biopsy data, while in one patient MRSI failed to detect cancer (gleason 3+4) in the lobe with the smaller percentage of tumoral tissue in the obtained cylinders (10% vs 30-70%). Of the remaining 16 patients with unilateral disease, MRSI successfully identified the affected lobe (Figure 1) and, in addition, in 9 of such cases showed some degree of extension to the contralateral lobe. MRSI did not detect cancer voxels in 16 (84.2 %) of the 19 patients with no evidence of the disease, while suspicious voxels were found in 3 patients (15.8 %). Results in these 3 patients were considered false positives as none was subsequently found to have cancer. Histology of sextant biopsies showed signs of glandular hyperplasia in all cases, and a similar percentage of cases with accompanying non-specific chronic prostatitis or prostatic intraepithelial neoplasia (PIN) in false positives compared with true negatives (Table 1).

Discussion

Despite the limitations of the present study, our results reinforce the feasibility for clinical routine use of this method and show an excellent agreement between detection of MRS abnormalities and presence of malignancy. Our results also outline the known limitations and drawbacks of the technique: the effect of prior biopsies and insufficient post-biopsy interval (3), partial volume of normal tissue in small lesions leading to false negative results, and the existence of false positive results. As for the latter, our results, surprisingly, failed to find a correlation between the presence of chronic prostatitis and false positive results by MRS, as suggested by a previous study (4). Although there are several technical differences between this latter study and our own that may explain the discrepancy, in our opinion, the issue of false positives and their causes is still an open subject that merits further study.

References

1.Kurhanewicz J. Radiology. 198: 795-805, 1996. 2. Coakley FV. J Urol. 170: S69-75, 2003. Qayyum A. AJR 183:1079–1083, 2004. Shukla-Dave A. Radiology 231:717–724, 2004.

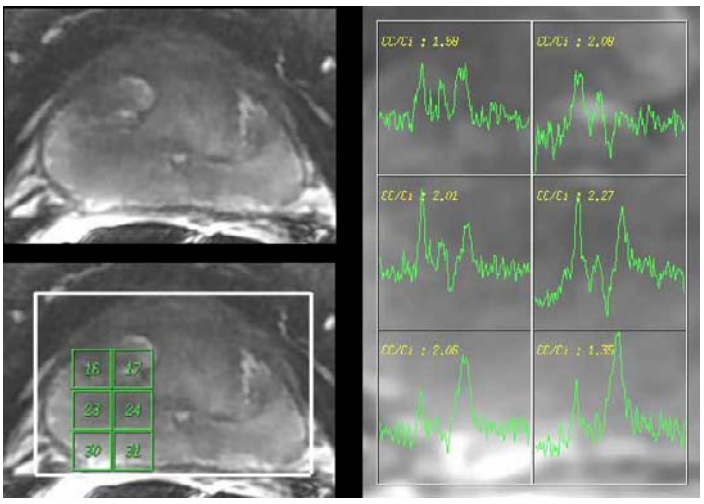

Figure 1. Representative example of agreement between histological data and MRSI results in a patient with proven adenocarcinoma of the prostatic right lobe, Gleason 8. Note on the right the spectra with intense choline peaks and high CC/Ci.

MRSI	prostatitis	PIN
True negatives (n=16 patients)	46.9	34.4
False positives (n= 3 patients)	50.0	33.3

Table 1. MRSI and histology findings in patients with no evidence of prostate cancer. Data are expressed in percentage of cases on the basis of lobe affectation.