D'Amico Risk Stratification Correlates With Degree of Suspicion of Prostate Cancer on Multiparametric Magnetic Resonance Imaging

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Purpose: We determined whether there is a correlation between D'Amico risk stratification and the degree of suspicion of prostate cancer on multiparametric magnetic resonance imaging based on targeted biopsies done with our electromagnetically tracked magnetic resonance imaging/ultrasound fusion platform.

Materials and Methods: A total of 101 patients underwent 3 Tesla multiparametric magnetic resonance imaging of the prostate, consisting of T2, dynamic contrast enhanced, diffusion weighted and spectroscopy images in cases suspicious for or with a diagnosis of prostate cancer. All prostate magnetic resonance imaging lesions were then identified and graded by the number of positive modalities, including low—2 or fewer, moderate—3 and high—4 showing suspicion on multiparametric magnetic resonance imaging. The biopsy protocol included standard 12-core biopsy, followed by real-time magnetic resonance imaging/ultrasound fusion targeted biopsies of the suspicious magnetic resonance lesions. Cases and lesions were stratified by the D'Amico risk stratification.

Results: In this screening population 90.1% of men had a negative digital rectal examination. Mean ± SD age was 62.7 ± 8.3 years and median prostate specific antigen was 5.8 ng/ml. Of the cases 54.5% were positive for cancer on protocol biopsy. Chi-square analysis revealed a statistically significant correlation between magnetic resonance suspicion and D'Amico risk stratification ($p < 0.0001$). Within cluster resampling demonstrated a statistically significant correlation between magnetic resonance suspicion and D'Amico risk stratification for magnetic resonance targeted core biopsies and magnetic resonance lesions ($p < 0.01$)

Conclusions: Our data support the notion that using multiparametric magnetic resonance prostate imaging one may assess the degree of risk associated with magnetic resonance visible lesions in the prostate.

Key Words: prostate, prostatic neoplasms, biopsy, magnetic resonance imaging, ultrasonography

Abbreviations and Acronyms

DCE = dynamic contrast enhanced
DRE = digital rectal examination
MP = multiparametric
MR = magnetic resonance
MRI = MR imaging
PSA = prostate specific antigen
TRUS = transrectal US
T2W = T2-weighted
US = ultrasound

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PROSTATE cancer is the leading cause of cancer in American men with 217,730 new cases in 2009 and the second most common cause of cancer related death.[1] Since 1986, the landscape of prostate cancer has changed significantly in re-

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gard to screening, age at diagnosis, incidence and stage at diagnosis. Inherent bias is introduced when transrectal US guided biopsy is used to screen and diagnose patients with prostate cancer due to sampling error.[2] We evaluated MP endorectal coil MRI and its correlation with prostate biopsy findings.

Initially prostate MRI was not considered for routine clinical practice.[3] However, adding an endorectal coil probe, functional imaging and a 3 Tesla magnet has dramatically improved its clinical and diagnostic usefulness.[4,5] Wefer et al reported an early series that combined T2 MR, MR spectroscopy and TRUS guided biopsy, and achieved 98% specificity for identifying patients with prostate cancer.[6] These initial observations helped set the foundation for using MRI in patients with suspected prostate cancer.

We believe that the underlying motivation for imaging in prostate cancer cases is to obtain a more complete pretreatment clinical picture with the possible but unproven goal of achieving better tailored treatment in our cases since 1/5 is upgraded after radical prostatectomy.[7] This is even more relevant with the increased use of radiation therapy and focal or whole gland ablation to treat patients with prostate cancer. Unfortunately one will never be able to assess whether these cases were under graded at treatment. The overall effect on clinical outcome is unclear but prostate cancer imaging and its impact on clinical outcomes merit continued research.

To meet this challenge of using MR images but moving biopsy out of the MR gantry a custom platform was developed at National Institutes of Health that fuses real-time TRUS with previously obtained prostate MR images using an electromagnetic tracking system. The urologist can then perform image guided transrectal prostate biopsy of MR identified areas suspicious for prostate cancer (targets), in addition to standard 12-core biopsy, with the ease and familiarity of the real-time TRUS prostate biopsies that urologists already perform. The technical aspects of this platform were previously described.[8,9] We now report the correlation between MP MRI suspicion for prostate cancer and biopsy results using the D'Amico risk stratification.

The D'Amico risk stratification was applied due to its clinical usefulness. It is a confirmed, validated method to determine patient pretreatment prostate cancer specific mortality.[10] This stratification was applied to specific biopsy data on MRI visible lesions in the prostate due to the possibility of assessing the aggressiveness of an index lesion, which may help guide future care.

MATERIALS AND METHODS

All patients were counseled and informed consent was obtained with the supervision of the National Cancer Institute institutional review board, which approved this prospective trial. From March 2007 to June 2009, 101 consecutive patients entered the protocol and underwent 3 Tesla MP endorectal coil MRI of the prostate, followed by biopsy under monitored anesthesia care. Study patients were referred to the National Cancer Institute with suspicion or a previous diagnosis of prostate cancer. All patients with previous prostate cancer treatment were excluded from study.

MP endorectal coil MRI of the prostate was performed with triplane T2W, DCE, diffusion-weighted and proton MR spectroscopy images obtained. If patients had undergone previous biopsy, imaging was delayed for at least 8 weeks to decrease the effect of post-biopsy hemorrhage on MRI. These images were interpreted by 2 radiologists (PC and BT) with expertise in reading prostate MRI. Intraprostatic MRI lesions were identified and then scored by the number of modalities positive on MRI in nonweighted fashion, including low—2 or fewer of 4, moderate—3 of 4 or high suspicion—4 of 4 on MRI for prostate cancer (fig. 1).

Before biopsy each patient received a cleansing Fleet® enema and standard antibiotic prophylaxis. The protocol required each patient to undergo standard 12-core TRUS biopsy, followed by MRI/US fusion biopsy of suspicious MR lesions using a custom prototype prostate navigation system that has Food and Drug Administration 510(K) clearance. Details of this novel biopsy platform were described previously.[8,9]

Preoperatively MR images were imported directly from the picture archiving and communication system. An electromagnetic field generator was placed above the pelvis, which allows real-time tracking of a custom biopsy needle guide embedded with a miniature electromagnetic tracking sensor.

A 2-dimensional prostate sweep was done manually to render a 3-dimensional US image, which was then registered and fused to preoperative prostate MR images.[9] The endorectal coil used in conjunction with MRI improves image quality. Also, there is a slight distortion of the prostate, similar to the effects of the TRUS probe used during the 2-dimensional prostate sweep, possibly aiding image fusion. Tracking also allows motion compensation to improve image registration. The real-time TRUS images were fused to the axial T2W MR images and selected MRI lesions were labeled for tracking (fig. 2). The physician manually guided the biopsy gun to the highlighted lesion visualized on MR and US fused images. After alignment 2 biopsies were done per lesion with a minimum of 1 biopsy in the axial and sagittal planes. To ensure core length greater than 5 mm occasionally additional biopsies were taken (up to 4). Each specimen was sent in a separate container for pathological evaluation.

Descriptive statistics are used to describe patient characteristics, including age, prebiopsy PSA, DRE, prostate volume and previous biopsy data. A statistician (JS) performed all study calculations. All pathological findings were reviewed by a single pathologist. Results