Multiparametric 3T MR Imaging of Prostate Cancer: Histopathologic Correlation Using Customized MRI-Based Specimen Molds

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INTRODUCTION: Prostate cancer is the most common cancer among American men with 217,730 estimated new cases and 32,050 deaths expected in 2010 (1). Magnetic resonance imaging (MRI) including both anatomical and functional sequences has been shown to be effective in detection and local staging of prostate cancer. However, there are limitations in validating MRI findings even with whole mount histopathological as the “gold standard” since free-hand slicing can easily result in deformation and, off-axis slicing of the prostate resulting in histologic sections that are different from MRI making it difficult to assess the true accuracy of MRI (2). Herein, we describe a custom-printed specimen mold that is based on the data extracted from the MRI, which allows sectioning the prostate in the exact plane as the in vivo MR slices. The findings of multi-parametric (MP) MRI (T2 weighted [T2W] MRI, apparent diffusion coefficient [ADC] maps of diffusion weighted [DW] MRI) MR spectroscopy, dynamic contrast enhanced [DCE] MRI) were then correlated with registered histopathological slices.

METHODS: This prospective single institution study was approved by the local IRB and was compliant with HIPAA; informed consent was obtained from each patient. The study population included forty-five patients (mean age 60.2 years, range 49-75 years) with a mean PSA level of 6.37ng/mL (range 2.3–23.7ng/mL), who had TRUS guided biopsy proven prostate cancer diagnosis prior to MR imaging (Gleason score ranging from 6 to 9). All patients underwent MP MRI of the prostate on a 3 Tesla scanner (Achieva, Philips Medical Systems, Best, The Netherlands) using 16-channel cardiac (SENSE, Philips Medical Systems, Best, The Netherlands) and endorectal coils (BPX-30, Medrad, Pittsburgh, PA, USA). The MRI protocol included tri-plane T2W TSE MRI, DW MR images, the annotated histology images of each whole mount specimen. Histopathologic specimens. Histopathologic images were created (3). Following robotic radical prostatectomy, and 2-24 hours fixation, the specimen was sliced in 6mm sections in the mold (J). Tumors were mapped prospectively on MP MRI blinded to histopathology results by two experienced radiologists. Histopathologic specimens were mapped by location, size, and Gleason score by two pathologists blinded to MRI. The custom molded provided tissues blocks that have one to one correspondence to the in vivo MR images. The annotated histology images of each whole mount specimens were stringently correlated with the corresponding MP MR images (Figure 1). Sensitivity, specificity, positive and negative predictive values of MP MRI were calculated in peripheral zone (PZ) and central gland (CG). The lesions of size [greatest diameter ≤5 mm vs. >5 mm] and Gleason score [≤7 vs. >7]) on sensitivity of MP MRI: were also evaluated.

RESULTS: A total of 1746 sectors (1164 in PZ, 582 in CG) were analyzed both in MP MRI and histopathologic specimens. Histopathologic evaluation revealed 341 tumor-positive sectors (280 in PZ, 61 CG). Sensitivity-specificity, PPV-NPV values of MRI sequences in different prostate zones are presented in tables 1 and 2, respectively. PPV of MP MRI of prostate at 3T enables accurate tumor detection and histologic correlation. It should be noted that this method could be applied to virtually any situation in which a surgical specimen needs to be correlated with a pre-operative MRI. Future work will focus on developing this technique to slice fresh specimens to allow the acquisition of proteomic samples from the tumor to improve assessment of tumor biology and to make thinner slices of 3mm to match the MR images better.

CONCLUSION: Our data indicates that MP MRI of prostate at 3T enables accurate tumor detection with reasonable sensitivity and specificity values in most cases. ADC maps of DW MRI and DCE MRI were the two most helpful techniques for tumor detection in the central gland, where a significant overlap between tumors and BPH changes usually occurs. MP MRI has better sensitivity for detecting larger (> 5 mm in diameter) and more aggressive (Gleason score of > 7) tumors. The use of the mold enables more exact correlation between each MR parameter and the histopathologic specimen. The customized mold provided tissues blocks that had a one to one correspondence with the in vivo MR. It should be noted that this method could be applied to virtually any situation in which a surgical specimen needs to be correlated with a pre-operative MRI. Future work will focus on developing this technique to slice fresh specimens to allow the acquisition of proteomic samples from the tumor to improve assessment of tumor biology and to make thinner slices of 3mm to match the MR images better.

References