How Accurate Is Multiparametric MR Imaging in Evaluation of Prostate Cancer Volume?


Abstract

Purpose To assess the factors influencing multiparametric (MP multiparametric) magnetic resonance (MR) imaging accuracy in estimating prostate cancer histologic volume ($V_h$ histologic volume). Materials and Methods A prospective database of 202 patients who underwent MP multiparametric MR imaging before radical prostatectomy was retrospectively used. Institutional review board approval and informed consent were obtained. Two independent radiologists delineated areas suspicious for cancer on images (T2-weighted, diffusion-weighted, dynamic contrast material-enhanced [DCE dynamic contrast enhanced] pulse sequences) and scored their degree of suspicion of malignancy by using a five-level Likert score. One pathologist delineated cancers on whole-mount prostatectomy sections and calculated their volume by using digitized planimetry. Volumes of MR true-positive lesions were measured on T2-weighted images ($V_{T2}$ volume measured on a T2-weighted image), on ADC apparent diffusion coefficient maps ($V_{ADC}$ volume measured on an ADC map), and on DCE dynamic contrast enhanced images ($V_{DCE}$ volume measured on a DCE image). $V_{T2}$ volume measured on a T2-weighted image, $V_{ADC}$ volume measured on an ADC map, $V_{DCE}$ volume measured on a DCE image and the greatest volume determined on images from any of the individual MR pulse sequences ($V_{max}$ greatest volume determined with images from any of the individual MR pulse sequences) were compared with $V_h$ histologic volume (Bland-Altman analysis). Factors influencing MP multiparametric MR imaging accuracy, or $A$, calculated as $A = V_{max}$ greatest volume determined with images from any of the individual MR pulse sequences / $V_h$ histologic volume, were evaluated using generalized linear mixed models. Results For both readers, $V_h$ histologic volume was significantly underestimated with $V_{T2}$ volume measured on a T2-weighted image ($P < .0001$, both), $V_{ADC}$ volume measured on an ADC map ($P < .0001$, both), and on DCE dynamic contrast enhanced images ($V_{DCE}$ volume measured on a DCE image). $V_{T2}$ volume measured on a T2-weighted image, $V_{ADC}$ volume measured on an ADC map, $V_{DCE}$ volume measured on a DCE image and the greatest volume determined on images from any of the individual MR pulse sequences ($V_{max}$ greatest volume determined with images from any of the individual MR pulse sequences) were compared with $V_h$ histologic volume (Bland-Altman analysis). Factors influencing MP multiparametric MR imaging accuracy, or $A$, calculated as $A = V_{max}$ greatest volume determined with images from any of the individual MR pulse sequences / $V_h$ histologic volume, were evaluated using generalized linear mixed models. Results For both readers, $V_h$ histologic volume was significantly underestimated with $V_{T2}$ volume measured on a T2-weighted image ($P < .0001$, both), $V_{ADC}$ volume measured on an ADC map ($P < .0001$, both), and on DCE dynamic contrast enhanced images ($V_{DCE}$ volume measured on a DCE image ($P = .02$ and $P = .003$, readers 1 and 2, respectively), but not with $V_{max}$ greatest volume determined with images from any of the individual MR pulse sequences ($P = .02$ and $P = .003$, readers 1 and 2, respectively). Mean, 25th percentile, and 75th percentile, respectively, for $V_{max}$ greatest volume determined with images from any of the individual MR pulse sequences accuracy were 0.92, 0.54, and 1.85 for reader 1 and 0.95, 0.57, and 1.77 for reader 2. At generalized linear mixed (multivariate) analysis, tumor Likert score ($P < .0001$), Gleason score ($P = .009$), and $V_h$ histologic volume ($P < .0001$) significantly influenced $V_{max}$ greatest volume determined with images from any of the individual MR pulse sequences accuracy (both readers). This accuracy was good in tumors with a Gleason score of 7 or higher or a Likert score of 5, with a tendency toward underestimation of $V_h$ histologic volume; accuracy was poor in small ($<0.5$ cc) or low-grade (Gleason score ≤6) tumors, with a tendency toward overestimation of $V_h$ histologic volume. Conclusion $V_h$ histologic volume can be estimated by using $V_{max}$ greatest volume determined with images from any of the individual MR pulse sequences in aggressive tumors or in tumors with high Likert scores. © RSNA, 2014.