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PRESENTATION TITLE
Prostate tumor prediction model for automated delineation QA on multiparametric MRI

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ABSTRACT
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Purpose: Focal dose escalation in the prostate requires reliable and reproducible tumor delineations on multiparametric (mp-) MRI. In the absence of contouring guidelines delineation variability is considerable. Here we investigated the applicability of a tumor prediction model to serve as a quality assurance tool for manual tumor delineations by radiation oncologists. We studied the feasibility to select delineations that require additional review.

Materials & Methods: We included 230 patients from three institutes: UMC Utrecht (n = 144), UZ Leuven (n = 34) and NKI Amsterdam (n = 52). Patients were scanned with a mp-MRI exam consisting of a T2w, DWI and DCE scan; ADC and Ktrans maps were derived. A set of 31 features was constructed from 29 image characteristics from the T2w, ADC and Ktrans map, and combined with biopsy report and tumor prevalence [1]. A published logistic regression model validated with histopathology data was applied to the feature set to calculate a voxel-level tumor probability (TP) within the delineated prostate [2]. Agreement between the predicted tumor location and the manual delineations was evaluated with the area under the ROC (AUC) curve. We selected patients with largest disagreement for further review by a uroradiologist.

Results: We found a median AUC of 0.81 (range 0.19 – 0.99) for all calculated TP maps, indicating overall good agreement between the predicted tumor location and manual delineations. Figure 1 shows a histogram of the obtained AUC values. A uroradiologist re-delineated 5 patients with lowest AUC scores, that were between 0.19 – 0.49, displayed in Figure 2. The bottom row depicts a patient...
with good model performance, resulting from consistent information in the MRI and biopsy. In R-1 (AUC = 0.19) the tumor was delineated around a transurethral resection of the prostate (TURP). As such signal intensities were opposite from tumor tissue, resulting in disagreement between TP map and manual contour. Upon review the tumor was localized in the left PZ. In R-2 the reviewer suspected tumor tissue in the dorsolateral left PZ as well, so that the whole prostate was suspected for tumor. Again a TURP showed up, resulting in a low AUC of 0.31.

For patients R-3 and R-4 the reviewer agreed with the location of the tumor. However, major modifications were made to the original delineations based on local MRI signal intensities. In R-5 the reviewer regarded the clinical delineation as non-malignant, but instead identified a tumor region on the left apex side of the prostate.

Conclusions: Automatic prediction of tumor location in the prostate resulted in good agreement with clinical delineations. We were able to use AUC as a performance indicator to specifically select delineations that showed to be outlier cases and required additional review.

Figure 1. (above) Histogram of obtained AUC values for the cohort of 230 patients after comparison of calculated TP maps with clinical delineations of prostate tumors.

Figure 2. (right) Compilation of 5 patients (R-1 – R-5) with lowest AUC values reported, together with 1 example of a high AUC (P-1). Original clinical delineation is in red, delineation after review in blue, prostate delineation in green. R-5 shows 2 slices of the prostate, since upon review the tumor is identified on a different slice than the original delineation.