A multi-site study to develop a new pseudo-quantitative T2w MRI map for prostate cancer characterization: Preliminary findings

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TARGET AUDIENCE: Radiologists, quantitative imaging scientists.

PURPOSE: Great promise has been demonstrated recently in the use of MRI for detection and diagnosis of prostate cancer *in vivo*[1]. T2-weighted (T2w) MRI has been primarily used for visualizing internal prostate structures and qualitatively identifying regions suspicious for cancer. However, T2w MRI signal intensity values are not truly quantitative as they are suffer from acquisition artifacts and differing image intensity ranges between different scanners and vendor platforms; also termed *intensity drift*[2]. This prevents objective assessment of T2w MRI (i.e. defining quantitative thresholds for cancer) as well as affecting creation of computerized decision support schemes (i.e. lack of consistent cancer-specific values across acquisitions). We present the first results of a multi-site study involving post-processing T2w MRI acquisitions from multiple institutions and scanners, to calculate a new pseudo-quantitative T2w parameter with tissue-specific meaning, to more accurately and reproducibly identify prostate cancer on MRI.

Parameters	Inst A	Inst B	Inst C
Matrix size	256 x 256	512 x 512	320 x 320
TR	6000-6016	4216-8266	2840-7500
TE	96-106.08	155-165	107-135
Number of cases	24	22	15

Table: Acquisition parameters for T2w MRI for 3 institutions, fast spin echo sequences used in all cases

METHODS: 61 *in vivo* endorectal T2w MRI studies were retrospectively obtained from 3 institutions (see Table), from patients previously diagnosed with prostate cancer on biopsy. Prostate capsule and peripheral zone were delineated using a minimally interactive segmentation method[3]. Prostate cancer regions on each T2w MRI dataset were annotated using available whole-mount prostatectomy sections. Post-processing of each dataset involved: (a) correcting for bias field, occurring due to use of endorectal coil[4], (b) harmonizing image intensities to a template, where intensity values were mapped to specific intensity ranges to give them tissue-specific meaning.

RESULTS: Original T2w image intensities show marked overlap between normal peripheral zone and prostate cancer (high intensity range overlap between unfilled red, green boxplots in Figure), as well as variability between different institutions (high variance compared to dotted lines on unfilled boxplots). The pseudo-quantitative T2w parameter demonstrates minimal overlap between normal peripheral zone and prostate cancer (minimal intensity range overlap between highlighted red, green boxplots), and appears more consistent between different institutions (minimal variance with respect to solid lines on highlighted boxplots).

DISCUSSION: The pseudo-quantitative T2w parameter appears to (a) account for differences between scanners and institutions, and (b) ensures better differentiation between cancer and normal regions in the peripheral zone. Qualitatively, post-processing enables more consistent visualization of the prostate as well as of cancer regions between datasets and institutions.

CONCLUSION: We have presented the first results of a multi-site study in developing and evaluating a post-processed pseudo-quantitative T2w parameter, which appears to have improved tissue specific meaning compared to the original signal intensity. This may help quantitatively distinguish prostate cancer from normal regions in computer-aided diagnostic systems.

REFERENCES: [1]Rais-Bahrami et al, Curr Urol Reports, 15: 387, 2014. [2]Nyul et al., Mag Res Med, 42: 1072-1081, 1999 [3]Toth et al IEEE Trans Med Img, 31(8): 1638-50, 2012. [4]Schnall et al, Radiology, 172(2): 570-4 (1989).

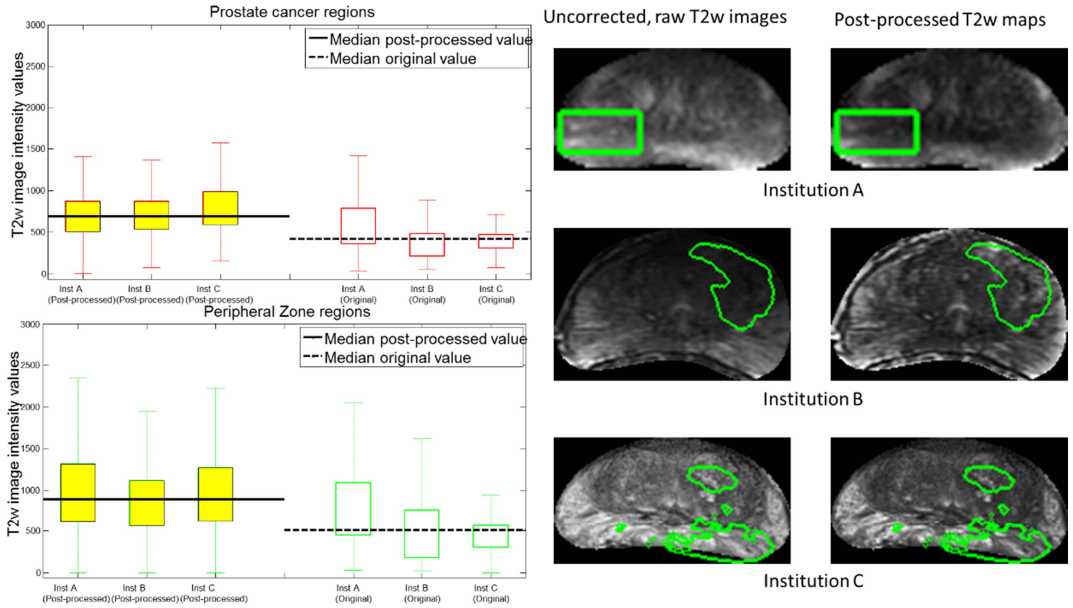

Figure: Boxplots comparing pseudo-quantitative T2w parameter to original T2w MRI signal intensity across 3 different institutions, for prostate cancer (red, above) and normal peripheral zone (green, below). Highlighted boxes correspond to pseudo-quantitative parameter, while unfilled boxes correspond to the original T2w MRI signal intensity value. The median value in each case has been plotted, to demonstrate variability across institutions, with and without post-processing. Also shown are qualitative comparisons of the uncorrected T2w MRI image and the post-processed T2w MRI map. As a result of post-processing, the pseudo-quantitative T2w parameter appears to more reliably differentiate prostate cancer from normal peripheral zone.