MR Diffusion-Weighted Imaging in Prostate Cancer:A valuable Tool for MR-guided Biopsy?

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INTRODUCTION

Conventional endorectal MR imaging (MRI) with T2-weighted turbo-spin echo (T2w) sequences provide the most accurate prediction of pathologic outcome of extracapsular extension and seminal vesicle invasion. Limited accuracy for tumor localization, however, is related to frequent concomitant findings related to benign disorders, e.g. inflammation, benign prostatic hyperplasia and postbioptic haemorrhage. Diffusion weighted MR imaging (DWI) and mapping of the apparent diffusion coefficient (ADC) enables to visualize the local water diffusion capacity and is therefore reflecting increased cell densities in areas of prostate cancer [1-5]. The combination of T2w MRI and MR-guided biopsy has been proven as a valuable tool for histological detection of prostate cancer in previous negative TRUS-guided biopsy patients [6]. Multimodal imaging including T1w dynamic contrast enhanced (DCE) imaging, MR spectroscopic imaging (MRSI) and DWI has to be proven superior for tumor localisation and planning of MR-guided interventions [6]. During MR- intervention, however, T1w DCE and MRSI are relative time consuming with respect to data acquisition and evaluation. DWI on the other can be fast acquired, repeated in any required orientations according to the needle guidance as well as evaluated without complex data post processing. Goal of this study was to evaluate the accuracy of DWI for localization of tumors accessible to MR-guided prostate biopsy.

MATERIALS & METHODS

In this study, 41 patients with biopsy proven prostate cancer scheduled for radical prostatectomy (RP) were included and underwent MRI before surgery at 1.5 Tesla (Magnetom Sonata, Siemens; Erlangen, Germany) using a standard endorectal coil (Medrad, Germany) and a surface array coil. The imaging protocol included transverse and coronal high-resolution T2- weighted Turbo Spin Echo sequences (slice thickness 3 mm, in plane resolution 0.8 x 0.4 x 3.0 mm3) and diffusion weighted imaging (DWI, single-shot EPI sequence, b-values 50, 400 and 600 s/mm^2, slice thickness 3 mm, in plane resolution 1.5 x 1.0 x 2.0 mm3). ADC maps were generated based on the three b-values 3-scan trace. RP specimens were serially step sectioned and whole mounted after the Stanford protocol, tumor areas were marked by felt pen and each prostate was divided into 12 sectors (apical/ mid/ basal - dorsal /ventral /right /left). Areas suspicious for prostate cancer were correlated with the corresponding whole mounted sections by sector. T2w-, DWI images and whole-mount sections were evaluated by two experienced genitourinary radiologists, one urologist and one pathologist in a consensus reading process.

RESULTS

492 prostate sectors were evaluated. Most tumors were multifocal (90% of the patients). In total, 97 foci of prostate cancer were present at pathological evaluation, with multiple foci of cancer in 90% of the 41 patients. 19.6% (n=19) of the cancer foci had a diameter of less than 5mm. DWI displayed 49 of 97 cancer foci (sensitivity: 51%). Three on T2w MRI suspicious, but based on histology false positive areas, were correctly not displayed by DWI. Twelve cancer foci (12,4%) were detected only by T2w MRI. Based on prostate sectors, the overall sensitivity of DWI was calculated to 51% and the specificity to 99%. For lesions larger than 1 cm, however, sensitivity and specifity were 100%. The positive predictive value of DWI was 94% with a negative predictive value of 89%.

CONCLUSION

Multifocality of cancer was found in 90% of the patients on histopathologic whole mounted sections. About 20% of the tumor sites were smaller than 5mm and neither detectable by T2w MRI nor DWI. On the other hand, it would be doubtful, whether these small lesions would be accessible by MRI-guided biopsy. Regarding lesions larger than 5 mm - 10 mm, however, DWI prooved to be a high-specific imaging modality for lesion characterization and tumor detection (figure 1). It is particularly important to note, that DWI yielded no false positive findings. The application would therefore not increase the amount of negative MR-guided prostate biopsies.

DWI including automatic calculation of ADC maps is fast and robust to perform and applicable within a MR guided biopsy procedure. The accuracy of DWI for tumor detection and its usability for MR-guided biopsy within one single examination could be further improved at 3.0 Tesla enabling higher spatial resolution and the application of higher b-values.
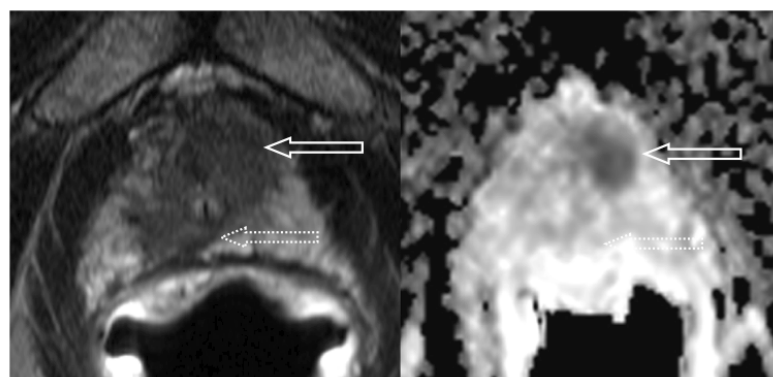
FIGURE 1

63 year old patient with a PSA of 6.9 ng/ml. T2w MRI displays two ares with suspicious signal loss in the apical peripheral zone on both sides (arrow and dotted arrow). ADC map shows only one lesion on the left side ventrally (arrow). Based on histopathology cancer was confirmed only on the left side ventrally (arrow). Gleason-Grade was 7(3+4).

REFERENCES

1. Kurhanewicz J et al.: Curr Opin Urol. 2008 Jan;18(1):71-7. Review.
2. Chen M et al.: Acta Radiol, 2008. 49(5): p. 602-10.
3. Haider MA et al.: AJR Am J Roentgenol, 2007. 189(2): p. 323-8.
4. Yoshimitsu K et al.: J Magn Reson Imaging, 2008. 27(1): p. 132-9.
5. Pickles MD et al.: J Magn Reson Imaging, 2006. 23(2): p. 130-4.
6. Lichy MP et al.:Urology. 2007 Jun;69(6):1208.e5-8.
7. Anastasiadis AG et al.: Eur Urol. 2006 Oct;50(4):738-48; discussion 748-9