What is the Most Effective Tool for Detecting Prostate Cancer using a Standard MR Scanner?

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Purpose: We aimed to determine which of the following magnetic resonance (MR) imaging sequences is most effective for detecting prostate cancer: T₂-weighted (T₂W), dynamic contrast-enhanced (DCE) T₁-weighted (T₁W), or diffusion-weighted (DWI) imaging or apparent diffusion coefficient (ADC) mapping.

Materials and Methods: We included 37 male patients with prostate cancer who underwent MR imaging before radical prostatectomy in this retrospective study. Sixty-four foci (> 5 mm in size; 35 in the peripheral zone [PZ], 29 in the transitional zone [TZ]) were histopathologically determined to be prostate cancer. We determined the capacity of T₂W, DCE-T₁W, DWI, ADC mapping alone, and the combination of ADC mapping with DWI, and conventional MR sequences to detect prostate cancer, including their sensitivity and positive predictive value (PPV), with reference to the results obtained in histopathological examinations of whole-mount sections.

Results: In the PZ, sensitivities were 31.4% (T₂W), 37.1% (DCE-T₁W), 51.4% (DWI), and 71.4% (ADC mapping); PPVs were 78.6% (T₂W), 92.9% (DCE-T₁W), 94.7% (DWI), and 96.0% (ADC mapping). Sensitivity was significantly higher of ADC mapping than other sequences. In the TZ, sensitivities were 55.1% (T₂W), 44.8% (DCE-T₁W), 82.8% (DWI), and 89.7% (ADC mapping); PPVs were 64.0% (T₂W), 46.4% (DCE-T₁W), 70.6% (DWI), and 72.2% (ADC mapping). Sensitivity was significantly higher of ADC mapping and DWI than conventional MR imaging, but there was no significant correlation between DWI/ADC mapping and T₂W/DCE-T₁W with respect to PPVs. Combining sequences did not improve sensitivity; only the PPV in the TZ improved when ADC mapping was combined with DCE-T₁W.

Conclusion: ADC mapping is the most effective standard MR imaging tool for detecting prostate cancer. The addition of DCE-T₁W may improve the PPV of ADC mapping for diagnosing cancer in the TZ.

Keywords: apparent diffusion coefficient, diffusion-weighted imaging, prostate cancer

Introduction

Accurate detection and localization of cancerous tissue can reduce the number of biopsies required for patients with elevated levels of prostate-specific antigen and help determine the most appropriate therapeutic options.¹ Knowledge of tumor location within the prostate can help direct maximal therapy to the largest focus of the tumor and minimize damage to surrounding structures, such as the neurovascular bundles, rectal wall, and neck of the bladder.

Magnetic resonance (MR) imaging has been used to delineate the initial extent of cancer and in checkups following therapy.² The apparent diffu-
sion coefficient (ADC) of cancerous tissue tends to be lower than that of normal prostate tissue, but an overlap between the ADC values of malignant and benign tissues may weaken the diagnostic capacity of diffusion-weighted imaging (DWI). Because ADC is dependent on the Brownian motion of water in biologic tissues, it is sensitive to the restricted diffusion that occurs in tumors due to their increased cellularity and fibrosis and decreased cellular size. Therefore, ADC evaluation may be helpful in assessing the aggressiveness of prostate cancers.

Recent studies have reported the use of DWI for detecting prostate cancer. DWI can localize prostate cancer with 42 to 90% sensitivity and 58 to 100% specificity. The combination of T2W imaging and ADC mapping has been shown to detect prostate cancer more accurately than T2W imaging alone. However, whether conventional MR imaging findings can add to the diagnostic accuracy of DWI/ADC mapping has not been fully established. Some studies have used ADC mapping to detect prostate cancer, but most have used DWI alone. Thus, comparisons between DWI and ADC mapping are rare.

The aim of this study is to determine the most effective MR sequence for detecting prostate cancer using a standard 1.5-tesla MR scanner. We assessed the following sequences: T2-weighted (T2W), dynamic contrast-enhanced (DCE) T1-weighted (T1W), DWI, and ADC mapping. Our previous report used the results of systemic biopsy as the reference standard. Similarly in this study, we used surgical specimens as the reference standards and compared imaging findings lesion by lesion.

Materials and Methods

Patients

This was a retrospective, single-institution study that followed the principles of the Declaration of Helsinki and was approved by our institutional review board. The need for written informed consent from patients was waived owing to the retrospective design of the study.

From January 2005 through July 2007, 63 patients underwent prostate MR imaging prior to systematic biopsy because of elevated prostate-specific antigen (PSA), positive results of digital examination, and/or positive results in transrectal ultrasonography. Biopsies were performed for all patients within 4 months after MR examination. We recruited for study 37 (aged 47 to 74 years, mean age, 66 years) of those 63 patients with positive biopsy results who were clinically determined to have stage B prostate cancer and who underwent radical prostatectomy. The prostatectomy specimens were staged according to the seventh edition of the TNM classification of malignant tumors.

MR imaging

All MR examinations were performed before biopsies because of the tendency for post-biopsy hemorrhage to create substantial artifacts on ADC map and DWI, the most common deterrent to accurate detection of prostate cancer. Patients underwent MR imaging on a 1.5T MR scanner (Signa Excite XI; GE Healthcare, Buckinghamshire, UK). Oblique-axial imaging planes were determined to be the short axis of the prostate in the sagittal localizing scan. For all sequences, slice thickness was 5 mm and inter-slice gap, 5 mm, such that approximately 10 sections were obtained for each patient.

T1W parameters were: fast spin echo (FSE); repetition time (TR)/echo time (TE), 5000 ms/87.9 ms; echo train length, 18; matrix size, 288×192; number of excitations (NEX), 4; and acquisition time, 3 min 45 s. T1-weighted (T1W) parameters were: FSE; TR/TE, 560 ms/12 ms; echo train length, 2; matrix size, 256×192; NEX, 2; and acquisition time, one min 50 s. Diffusion-weighted (single-shot echo planar) imaging (DWI) parameters were: TR/TE, 3600 ms/72.6 ms; matrix size, 160×128; NEX, 8; and acquisition time, one min 55 s. Gadolinium-enhanced dynamic MR imaging parameters were: fat-suppressed fast spoiled gradient-recalled acquisition in steady state (FSPGR); TR/TE/flip angle, 130 ms/2.0 ms/90°; matrix size, 256×160; NEX, one; and acquisition time, 22 s.

All imaging procedures were performed using 8-channel torso-array coils. The field of view was 36 cm for DWI and 18 cm for other sequences. For DWI, images were obtained using diffusion gradients with 2 b-values (0 and 1000 s/mm²) along the 3 directions of the motion-probing gradients. Array spatial sensitivity encoding parallel imaging technique (ASSET) was used with a reduction factor of 2. In dynamic scans, precontrast baselines at 40 and 180 s after bolus injection of 0.1 mmol/kg gadopentetate dimeglumine (Magnevist; Bayer Schering Pharma, Osaka, Japan) were obtained sequentially.

Comparison with histopathologic step sections

We determined the reference standards in this
study by the results of step sections from prostatectomy specimens. Approximately 7 hematoxylin-eosin (H & E)-stained sections were obtained from histopathologic specimens. A pathologist circled cancerous regions in these sections with a red pen and carefully drew schemata and assigned a Gleason score to each cancerous focus corresponding to the circled regions. A radiologist visually matched each histopathologic slice to a corresponding MR image on the basis of the location of the ejaculatory ducts, diameter of the prostate, and approximate distance from the base or apex.

This study included 64 cancerous foci with maximum diameter greater than 5 mm. We excluded smaller foci because they might be difficult to visualize in MR with slice thickness of 5 mm. Lesions in the peripheral zone (PZ) and inner gland (TZ) were evaluated separately.

**Histopathology-MR image correspondence and image analyses**

All image analyses were performed on a workstation (AW version 4.4; GE Healthcare). ADC maps were constructed on the workstation and simultaneously displayed to readers during image analysis. In consensus, 2 radiologists with 10 and 20 years' experience in body MR imaging reviewed the regions on the MR images that corresponded to the 64 cancerous foci delineated by the pathologist. To measure the ADC values, each region of interest (ROI) on the ADC maps was carefully placed to ensure its location corresponded to the cancerous tissue in the histopathologic sections. With the histopathologic sections as a reference, ROIs were made as large as possible within the cancerous areas. ROI placement was determined by the consensus. The minimum ROI diameter in our series was 5 mm, which yielded a minimum ROI area of 19.6 mm².

Images were interpreted as positive, negative, or equivocal without knowledge of histopathological findings on the basis of visual criteria only. For T₁W images, the criteria for cancer presence were either a mass or nodule of homogeneous low signal intensity relative to a normal peripheral zone accompanied by disruption of the duct structure in the PZ or an area with homogeneous low signal intensity and ill-defined margins in the TZ. Linear regions, the absence of low signal intensity, and regions surrounding the capsule structure were considered noncancerous.

For DCE-T₁W images, cancer was identified on the basis of the presence, asymmetry, and degree of enhancement, especially early nodular enhancement (before enhancement of the rest of the prostatic tissue and pelvic muscles). Early washout of contrast agent was considered to increase the probability of cancer. Regions with gradual enhancement in the delayed phase or no apparent enhancement were considered benign.

For DWI and ADC mapping, cancer was identified by the presence of focal or conglomerated lesions (hyperintense in DWI and hypointense in ADC mapping) relative to the surrounding prostatic structures. Regions with a slightly high focal signal on ADC mapping, slightly low signal intensity on DWI relative to the background prostate parenchyma, or high or homogeneous intensity on ADC map relative to the surrounding prostate parenchyma were considered negative (Table 1). In interpreting the results of DCE-T₁W, DWI, and ADC mapping, we referred to the results of T₁W to confirm the anatomic positions after assessment of each image. We calculated the capability of T₁W, DCE-T₁W, DWI, and ADC mapping to detect prostate cancer, including their sensitivities and positive predictive values (PPVs). To assess whether conventional MR imaging findings can add to the diagnostic accuracy of DWI/ADC mapping, we also calculated the sensitivity and PPV for the combined criteria, the combination of ADC mapping/DWI and conventional MR findings. For assessments with combined criteria, conventional MR findings were divided into inclusion and exclusion criteria (Table 1). Four datasets, collected at 3-week intervals, were interpreted for each patient, and sensitivity and PPV were calculated. The sensitivity and PPV for assessments involving combined criteria were calculated from 4 datasets.

**Statistical analysis**

We used Kruskal-Wallis and Fisher’s exact tests to examine the statistical significance of differences in sensitivity and PPV between MR sequences and Spearman’s rank correlation coefficient (rₛ) to assess relationships between ADC values in cancers of both the PZ and TZ and tumor Gleason scores. All statistical analyses were performed using Excel Statistics 2008 (SSRI, Tokyo, Japan). In all statistical analyses, \( P < 0.05 \) was considered statistically significant.

**Results**

PSA levels among the 37 patients ranged from 3.9 to 24.0 ng/mL (8.3\[4.4\] ng/mL, mean [SD]). All 37 prostatectomy specimens had a histopathologic diagnosis of cancer, and histopathologic grades were further defined using the Gleason score (Table 2). Table 3 shows the prostate cancer stage
Table 1. Diagnostic criteria for each magnetic resonance (MR) imaging sequence: T2-weighted (T2W); dynamic contrast-enhanced (DCE); and diffusion-weighted (DWI) imaging and apparent diffusion coefficient (ADC) mapping

| Sequence | Inclusion | Exclusion |
|----------|-----------|-----------|
| T2W      | Mass or nodule with homogeneous low signal intensity relative to normal peripheral zone (PZ) and accompanied by disruption of the duct structure in the PZ. Area with homogeneous low signal intensity, ill-defined margins in the transitional zone (TZ). | Linear region or absence of low signal intensity or a region surrounding a capsule structure in the TZ |
| DCE      | Presence, asymmetry, and degree of enhancement, especially early nodular enhancement (before enhancement of the rest of the prostatic tissue and pelvic muscles) and presence of early contrast agent washout | Region of gradual enhancement in the delayed phase or no apparent enhancement |
| DWI and ADC | Focal or conglomerated lesions, hyperintense in DWI and hypointense in ADC mapping, relative to surrounding prostatic structure | Region with slightly high focal signal on ADC map or slightly low signal intensity on DWI relative to the background prostate parenchyma or a region with high or homogeneous intensity on ADC map relative to the surrounding prostate parenchyma |

Table 2. Gleason scores for 64 cancerous foci in 37 patients

| Gleason score | Number of specimens |
|---------------|---------------------|
|               | Peripheral zone     | Transitional zone |
| 5             | 0                   | 1                 |
| 6             | 2                   | 2                 |
| 7             | 26                  | 24                |
| 8             | 2                   | 1                 |
| 9             | 5                   | 1                 |
| **Total**     | **35 (55.0%)**      | **29 (45.0%)**    |

Table 3. Stages of prostate cancer in 37 patients

| Stage | Number of patients |
|-------|--------------------|
| T2a   | 6                  |
| T2b   | 16                 |
| T3a   | 13                 |
| T3b   | 2                  |
| T4    | 0                  |
| **Total** | **37**             |

of the 37 patients as revealed by radical prostatectomy. Histopathologically, 13 of the 37 had extracapsular extensions, and two had seminal vesicle invasion.

Histopathology confirmed 64 cancerous foci—35 in the peripheral zone and 29 in the inner gland. Mean lesion size (maximum transverse diameter) was 12.0 mm (range, 5.0 to 28.0 mm).

Qualitative analysis of PZ cancer

Table 4 shows the sensitivities of T2W, DCE-T1W, DWI, and ADC mapping. The sensitivity of ADC mapping was significantly higher than that of conventional MR sequences, but there was no significant difference between the PPVs. Seven lesions were diagnosed on ADC mapping only, and one lesion was diagnosed on DCE-T1W only. No lesion could be diagnosed on only T2W or DWI. Combining modalities did not improve sensitivity or PPV (Table 5). Three false-positive regions were identified using T2W and one each by DCE-T1W, DWI, and ADC mapping. Histopathological analysis of the false-positive findings in the PZ revealed regions showing inflammatory changes with lymphocytic infiltration.

Qualitative analysis of TZ cancer

Table 6 shows the sensitivities of T2W, DCE-T1W, DWI, and ADC mapping in the TZ. The sensitivity of ADC mapping and DWI was significantly higher than that of conventional MR imaging, but there was no significant difference between PPVs for DWI/ADC mapping and T2W/DCE-T1W. Two lesions were diagnosed by only ADC mapping. No lesion could be diagnosed on only T2W, DCE-T1W, or DWI. Combining sequences did not improve sensitivity; only the PPV improved when ADC mapping was combined with DCE-T1W (Table 7). Nine false-positive regions were identified using T2W, 15 using DCE-T1W, and 10 each using DWI and ADC mapping. Histopathological analysis of the false-positive findings revealed cellular hyperplasia, glandular benign prostatic hyperplasia without degeneration, stromal/mixed hyper-
Table 4. Sensitivity and positive predictive value (PPV) for the capacity of each modality in detecting prostate cancer foci in the peripheral zone (PZ)

| T2W | DCE-MRI | DWI | ADC map | T2W and DCE-MRI imaging versus ADC map | T2W, DCE-MRI imaging versus DWI | DWI versus ADC map |
|-----|---------|-----|---------|----------------------------------------|--------------------------------|-------------------|
|     |         |     |         |            |                               |                  |
| Sensitivity (%) | 31.4 | 37.1 | 51.4 | 71.4 | P<0.05 | n.s. | P<0.05 |
| PPV (%)     | 78.6 | 92.9 | 94.7 | 96.0 | n.s.   | n.s.   | n.s.   |

Table 5. Sensitivity and positive predictive value (PPV) for the capacity of combined criteria in detecting prostate cancer foci in the peripheral zone (PZ)

|                                | Sensitivity (%) | PPV (%) |
|--------------------------------|-----------------|---------|
| met inclusion criteria for ADC map alone | 71.4 | 96.0 |
| met inclusion criteria for ADC map or for T2-weighted (T2W) imaging | 71.4 | 78.6 |
| met inclusion criteria for ADC map or for dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) | 74.3 | 92.9 |
| met inclusion criteria for ADC map and did not meet exclusion criteria for T2W | 68.6 | 96.0 |
| met inclusion criteria for ADC map and did not meet exclusion criteria for DCE-MRI | 68.6 | 96.0 |
| met inclusion criteria for diffusion-weighted imaging (DWI) alone | 51.4 | 94.7 |
| met inclusion criteria for DWI or for T2W | 51.4 | 81.8 |
| met inclusion criteria for DWI or for DCE-MRI | 54.3 | 90.5 |
| met inclusion criteria for DWI and did not meet exclusion criteria for T2W | 48.6 | 94.4 |
| met inclusion criteria for DWI and did not meet exclusion criteria for DCE-MRI | 48.6 | 94.4 |

Table 6. Sensitivity and positive predictive value (PPV) for the capacity of each modality to detect prostate cancer foci in the transitional zone (TZ)

| T2W | DCE-MRI imaging | DWI | ADC map | T2W and DCE-MRI imaging versus ADC map | T2W, DCE-MRI imaging versus DWI | DWI versus ADC map |
|-----|-----------------|-----|---------|----------------------------------------|--------------------------------|-------------------|
|     |                 |     |         |            |                               |                  |
| Sensitivity (%) | 55.1 | 44.8 | 82.8 | 89.7 | P<0.05 | P<0.05 | n.s. |
| PPV (%)     | 64.0 | 46.4 | 70.6 | 72.2 | n.s.   | n.s.   | n.s.   |

Table 7. Sensitivity and positive predictive value (PPV) for the capacity of combined criteria in detecting prostate cancer foci in the transitional zone (TZ)

|                                | Sensitivity (%) | PPV (%) |
|--------------------------------|-----------------|---------|
| met inclusion criteria for ADC map alone | 89.7 | 72.2 |
| met inclusion criteria for ADC map or for T2-weighted (T2W) imaging | 89.7 | 74.3 |
| met inclusion criteria for ADC map or for dynamic contrast-enhanced magnetic resonance (DCE-MRI) | 89.7 | 72.2 |
| met inclusion criteria for ADC map and did not meet exclusion criteria for T2W | 75.9 | 81.5 |
| met inclusion criteria for ADC map and did not meet exclusion criteria for DCE-MRI | 86.6 | 92.6* |
| met inclusion criteria for diffusion-weighted imaging (DWI) alone | 82.8 | 70.6 |
| met inclusion criteria for DWI or for T2W | 82.8 | 68.6 |
| met inclusion criteria for DWI or for DCE-MRI | 82.8 | 66.7 |
| met inclusion criteria for DWI and did not meet exclusion criteria for T2W | 69.0 | 74.0 |
| met inclusion criteria for DWI and did not meet exclusion criteria for DCE-MRI imaging | 79.3 | 85.2 |

* significantly higher than “ADC map alone”
plasia, lymphocyte infiltration, and fibrosis/thick-
ened capsule.

**Quantitative ADC value measurements**

Significant negative correlations were identified between Gleason scores of tumors and ADC values in total prostate cancers ($r_s = -0.35, \ P = 0.01$) or peripheral zone cancers ($r_s = -0.46, \ P = 0.01$). A marginally significant correlation was noted between ADC values of inner gland cancers and tumor Gleason scores ($r_s = -0.32, \ P = 0.09$) (Fig. 1). Figures 2 to 4 show representative cases.

**Discussion**

DWI has clinical applications for body imaging as a result of recent improvements in MR imaging technology, such as the use of high performance gradient coils, parallel imaging techniques, and phased-array receiver coils. Several preliminary studies measuring ADC values in prostate cancer have demonstrated lower ADC values in cancerous lesions than normal prostate tissues.19–23 These findings suggest that ADC values may further increase the specificity of prostate cancer diagnosis. Gleason score is the most commonly accepted and widely used system for evaluating the aggressiveness of prostate cancer. In our study, the mean tumor ADC value had a significant negative correlation with tumor Gleason score, a finding consistent with the results of previous reports.4,10,23–24 Possible explanations for this correlation include increased tumor cellularity, structural changes in the stroma causing the gland to become more fibrous, and a more disorganized texture of the gland resulting in more restricted motion of water molecules in tumors with high Gleason scores.4 These findings suggest that ADC mapping may be more useful than conventional MR imaging for detecting prostate cancer. Conversely, a reported overlap in ADC values between normal and tumor regions suggests limitations to the use of quantitative ADC measurements for detecting prostate cancer, especially in the TZ.23 Because of the greater overlap in ADC values between normal and tumor regions, the sensitivity of ADC mapping may not be significantly higher than that of DWI in the TZ.

To assess whether conventional MR imaging findings can add to the diagnostic accuracy of DWI/ADC mapping, we combined diagnostic criteria. Our results indicate that the sensitivity of T2W and DWI was not better than that cited in a previous

![Fig. 1. Scatter plots showing the relationship between apparent diffusion coefficient (ADC) values in cancer and tumor Gleason scores. (a) Total number of prostate cancers and Gleason scores. (b) Peripheral zone cancers and Gleason scores. (c) Inner gland cancers and Gleason scores. Significant negative correlations were identified between ADC values for the entire prostate and peripheral zone cancers and tumor Gleason scores ($r_s = -0.35, \ P = 0.01$; $r_s = -0.46, \ P = 0.01$), respectively. A marginally significant correlation was noted between ADC values in inner gland cancer and tumor Gleason scores ($r_s = -0.32, \ P = 0.09$).](image)
Fig. 2. Findings for a 63-year-old man with typical prostate cancer (moderately differentiated adenocarcinoma, Gleason score, $4+3=7$; capsule invasion [-]). When T2-weighted (T2W) sequence was used, an area of homogeneous low intensity without a capsule structure was noted in the left lobe of the prostate (a, arrow). Diffusion-weighted imaging (DWI; b, arrow) and apparent diffusion coefficient (ADC) mapping (c, arrow) clearly demonstrate decreased diffusion. The lesion was well enhanced in the early phase of the dynamic study (d, arrow). A histopathologic hematoxylin-eosin (H & E)-stained section shows the cancerous area corresponding to magnetic resonance (MR) image findings (e, arrow).

Fig. 3. Findings for a 73-year-old man with prostate cancer (moderately differentiated adenocarcinoma, Gleason score, $4+3=7$, capsule invasion [+]). Using T2-weighted (T2W) sequence, an area of low intensity surrounded by a capsule structure was noted in the left lobe of the prostate (a, arrow). Diffusion-weighted imaging (DWI) (b) /apparent diffusion coefficient (ADC) mapping (c) demonstrate decreased diffusion. The lesion was slightly enhanced in the early phase of dynamic study (d, arrow). A histopathologic hematoxylin-eosin (H & E)-stained section shows the cancerous area corresponding to magnetic resonance (MR) image findings (e, arrow). A lesion in the left peripheral zone (PZ) (e, arrowhead) was noted in T2W and DWI/ADC mapping, but a lesion in the right PZ was unclear in all protocols (e, open arrow).
Fig. 4. Findings for a 65-year-old man with prostate cancer (moderately differentiated adenocarcinoma, Gleason score, 4 + 3 = 7, capsule invasion [+]). When T2-weighted (T2W) sequence was used, an area of heterogeneous low intensity without a capsule structure was noted in the left lobe of the prostate (a, arrow). Apparent diffusion coefficient (ADC) mapping (c, arrow) demonstrated decreased diffusion, which was unclear in diffusion-weighted imaging (DWI) (b, arrow). The lesion showed slight enhancement in the early phase of the dynamic study (d, arrow). A histopathologic hematoxylin-eosin (H & E)-stained section shows the cancerous area corresponding to the magnetic resonance (MR) image findings (e, arrow). A lesion in the left peripheral zone (PZ; e, arrowhead) was unclear in all protocols.

report, probably because of the small size of the lesions (mean size, 12.0 mm). In addition, we established concordance between MR imaging and pathologic findings on a lesion-by-lesion basis. Prostate cancer in the PZ is usually demonstrated by low signal intensity that is well demarcated from the normal high signal intensity of that sequence. However, low signal intensities may be seen in the PZ on T2W imaging in the presence of many noncancerous conditions, such as hemorrhage, prostatitis, sequelae of radiation, and changes after hormonal therapy. The sensitivity of ADC mapping/DWI was significantly higher than that of conventional MR sequences, but there was no significant difference in the PPVs. Cancer in the TZ is poorly delineated because noncancerous, hyperplastic tissues often show low signal intensity and a heterogeneous appearance on T2W images. In this study, if ADC mapping was positive, sensitivity was not considered improved if both the T2W and dynamic MR imaging showed positive findings. A previous study indicated the capsular structure surrounding the TZ region to be benign, and we observed this in 17% (5/29) of the TZ cancers in this study. Therefore, we suggest that a region within the capsular structure cannot be assumed to be nonmalignant, as Oto and colleagues have reported. In our study, the PPV improved when ADC mapping was combined with DCE-T1W findings for the TZ. Fibrosis and a thickened capsule may cause false-positive findings on ADC mapping and show little or no apparent enhancement on DCE-T1W. Therefore, combining ADC mapping and DCE-T1W findings may improve the PPV.

Among the 52 lesions with positive MR findings in the present study, one lesion (2%) was diagnosed by only the conventional MR sequences of DCE-T1W. No lesion was diagnosed by only T2W or DWI. Twenty-one lesions (40%) were diagnosed by only DWI or ADC mapping, and 9 lesions (17%) were diagnosed by only ADC mapping. Our results indicate that ADC mapping could be mainly used for detecting prostate cancers. However, in an investigation of the effectiveness of T2W, DCE-T1W, and DWI, Tamada and associates reported that 9% of positive MR findings were diagnosed by DWI only. This difference could be attributable to
a difference in reference standards. By using only biopsy specimens as reference standards, Tamada’s group may have underestimated the potential of DWI.

Our study had several limitations. First, because we included patients who underwent radical prostatectomy, only patients with less aggressive and more localized prostate cancer were involved. Second, DWI was performed by setting b-values to only 0 and 1000 s/mm². It is still unclear whether this is the most appropriate b-value for DWI of the prostate at 1.5T. It can be argued that b-values are determined by a balance between diffusion weighting and image quality. Further studies using various b-values and imaging sequence modifications are required. Third, we did not consider lesions of less than 5-mm maximum diameter. Stamey and colleagues reported that prostate cancers smaller than 5-mm diameter is below 0.1 mL, our selection of cancerous lesions could be incomplete. Fourth, we could not assess specificity and negative predictive value due to a lack of true negatives. Finally, the correlation between imaging and histopathologic examination on a section-by-section basis has inherent limitations. The angle may differ between histopathologic stained sections and MR images. In addition, the prostate usually shrinks during fixation.

Conclusion

In summary, ADC mapping has a greater capacity than conventional MR imaging to detect local prostate cancer. ADC mapping may also be useful for predicting the aggressiveness of prostate cancer. ADC mapping of the prostate should be calculated from DWI in MR imaging in routine practice.

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