Clinical Relevance

Unnecessary prostate biopsies lead to unnecessary pain, complication risks, psychological stress and healthcare costs. Therefore, non-invasive imaging methods should help to reduce the number of unnecessary biopsies.

Purpose

To assess whether quantitative Apparent Diffusion Coefficient (ADC) measurements derived from Diffusion-Weighted Imaging (DWI) may help to obviate unnecessary biopsies in multiparametric MRI (mpMRI)-detected PI-RADS 4 & 5 lesions.

Patients and Methods

This local ethics committee-approved, retrospective study investigated 101 PI-RADS 4 & 5 prostate lesions (52 malignant, 49 benign) verified by in bore MRI-guided biopsy (Fig. 1) in 101 men (mean age: 62.8y). Two experienced readers blinded to the histopathological results independently and repeatedly measured minimum, mean, and maximum ADC from DWI measurements (in line with PI-RADS v2 recommendations) by placing a two-dimensional region-of-interest around the biopsied lesions. Receiver operating characteristic (ROC) statistics were used to analyze diagnostic performance and find optimal ADC thresholds, and reproducibility statistics were calculated.

Results

ADC was significantly lower in PCa compared to non-cancerous lesions (Fig. 2). Minimum ADC values showed the best diagnostic performance (overall AUC R1: 0.801; R2: 0.796 peripheral zone AUC R1:0.814, R2: 0.805; transitional zone AUC R1:0.786, R2:0.779) and the tightest limits of inter-reader agreement (8.6 to 9.9%). Thresholds (Tab. 1) to rule-in and rule-out prostate cancer (PCa) were identified and may avoid unnecessary biopsies in 32.7% (16/49).

Conclusion

Quantitative ADC measurements in mpMRI-detected PI-RADS 4 & 5 lesions has the potential to avoid unnecessary MRI-guided biopsies in up to 33%.

References

1. Multiparametric [18F]fluorodeoxyglucose positron emission tomography-magnetic resonance imaging in the assessment and staging of prostate cancer; Polanec et al. 2017 Plos One
2. Magnetic resonance imaging-guided prostate biopsy: institutional analysis and systematic review; Polanec et al 2014 Roefo
4. Diffusion-weighted imaging of breast lesions: Region-of-interest placement and different ADC parameters influence apparent diffusion coefficient values.; Bickel et al 2017 Euror Radiol

Table 1: ADC thresholds to rule in or rule out malignancy

<table>
<thead>
<tr>
<th>Location</th>
<th>Reader</th>
<th>ADC cut-off (\times 10^{-3}) mm²/s</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>95% CI (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General ((n=101))</td>
<td>1</td>
<td>≤0.616</td>
<td>42.31</td>
<td>91.84</td>
<td>80.4-97.7</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>≤0.616</td>
<td>40.18</td>
<td>91.84</td>
<td>80.4-97.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥0.972</td>
<td>89.81</td>
<td>32.65</td>
<td>19.4-47.5</td>
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<tr>
<td>Peripheral Zone ((n=49))</td>
<td>1</td>
<td>≤0.616</td>
<td>42.36</td>
<td>94.12</td>
<td>71.3-99.9</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>≤0.616</td>
<td>46.43</td>
<td>94.12</td>
<td>71.3-99.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥0.969</td>
<td>99.41</td>
<td>29.41</td>
<td>10.5-56.0</td>
</tr>
<tr>
<td>Transitional Zone ((n=52))</td>
<td>1</td>
<td>≤0.687</td>
<td>62.53</td>
<td>90.62</td>
<td>75.0-98.0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>≤0.687</td>
<td>62.81</td>
<td>90.62</td>
<td>75.0-98.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥0.972</td>
<td>95.83</td>
<td>34.38</td>
<td>18.6-53.2</td>
</tr>
</tbody>
</table>

Figure 1: 59-year-old patient with a suspicious lesion in the left peripheral zone (arrows). The lesion is moderately hypointense on the T2-weighted image (a), shows contrast enhancement (b) and an ADC value higher than 0.972×10⁻³ mm²/s (c). Histopathology obtained by MRI-guided biopsy (c) confirmed an inflammation.

Figure 2: Examples of a benign and a malignant prostate lesion: Gleason 8 (4+4) cancer in the anterior part of the prostate, presenting as a T2w-hypointense lesion (a) with an ADC lower than the threshold of 0.95×10⁻³ mm²/s (b). In contrast, a case of chronic prostatitis presenting as T2-hypointense (c), but with an ADC above the threshold (d).