Improving image quality in prostate MRI: the time is now

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Hip prostheses are commonly encountered in the elderly population undergoing prostate magnetic resonance imaging (MRI), causing susceptibility artefacts that can severely degrade image quality especially on diffusionweighted imaging (DWI). In this issue of European Radiology, Nakai et al specifically investigated the impact of susceptibility artefacts from hip prostheses on the diagnostic performance of MRI of the prostate [1]. The authors report the results from a large population that included three centres, for a total of 11,319 examinations, 5% of which with hip arthroplasty. Susceptibility artefacts from hip replacement graded as ‘moderate’ or ‘severe’ were reported in 57% of the cases, with a decreased cancer detection rate compared to patients without hip prostheses (74%). The reduced cancer detection rate in such patients was mainly attributed to an increased frequency of MRI-negative calls, likely due to the non-visibility of lesions with restricted diffusion. In addition, a lower pathological confirmation rate was observed for Prostate Imaging and Data Reporting System (PI-RADS) ≥ 3 lesions.

These findings confirm the importance of adequate diagnostic image quality for the efficient delivery of the MRI-directed diagnostic pathway in prostate cancer.

Following the global adoption of prostate MRI, the standardisation of image quality has become a top priority [2].

The PI-RADS v. 2.1 guidelines provide a set of technical requirements to acquire MR images of adequate diagnostic quality [3] and this has been also emphasised in a Delphi ESUR (European Society of Urogenital Imaging)/ ESUI (European Society of Urology Section of Urological Imaging) consensus meeting [4]. However, patient-related artefacts due to motion, rectal air and hip prostheses can affect image quality, limiting the utility of such recommendations.

The authors should be commended for creating a standardised simple scale to evaluate the degree of susceptibility artefacts from hip prostheses using the proportion of visible prostate volume, as it is important to have a reproducible scale to assess image quality in prostate MRI. A fundamental step towards standardisation of image quality was the introduction of the Prostate Imaging Quality (PI-QUAL) score [5] that is a 1-to-5 scale that evaluates the diagnostic quality of a scan based on a defined set of objective (against the PI-RADS technical recommendations) and subjective (i.e. evaluation of the conspicuity of certain anatomical structures and absence of artefacts, including those from hip prostheses) criteria. Since its introduction, several studies showed the potential implications of the PI-QUAL score in the clinical setting. Boschheidgen and colleagues assessed the rate and severity of artefacts from total hip replacement in 140 patients [6] and found that their frequency and severity

were similar for 1.5-T and 3-T scanners, with severe artefacts occurring in about 30%. In this context, PI-QUAL was helpful in determining the diagnostic value of MRI scans.

Karanasios and colleagues [7] reported that scans of nondiagnostic quality (i.e. PI-QUAL 1 and 2) were associated with a higher rate of indeterminate MRI findings (i.e. PIRADS 3 lesions) and a reduced ability to rule-in and ruleout clinically significant prostate cancer, confirming that low image quality increases the uncertainty in MRI scoring. Another study [8] reported a cohort of 300 patients who underwent biopsy following prostate MRI. Here, the authors found that the proportion of patients referred for biopsy with equivocal findings (i.e. PI-RADS 3) was higher for exams of lower image quality (i.e. PI-QUAL < 4) and that the detection rate of clinically significant prostate cancer in PI-RADS ≥ 3 lesions was reduced. Further refinements of PI-QUAL (i.e. PI-QUAL v. 2) are planned.

One of our future challenges as radiologists is to determine which strategies should be consistently adopted to increase image quality in routine clinical practice. Patient preparation with enema and antispasmodic agents is relatively inexpensive and has been reported to increase image quality [9]. On-scanner monitoring could help identify artefacts (e.g. patient movement, rectal air) that could benefit from sequence repetition or minor protocol changes, such as modification of the phase encoding direction from anterior/posterior to right/left [10]. As far as hip arthroplasty is concerned, the technical advances

in MRI scanners with availability of dedicated sequences could improve image quality and reduce susceptibility artefacts. Finally, we are at the beginning of a new era where artificial intelligence–based image reconstruction tools could be used to improve image quality and reduce acquisition time at the same time.

In conclusion, we welcome the findings by Nakai and colleagues as they highlight the importance of image quality in prostate MRI for patients with hip replacement. Ensuring images of high diagnostic quality is of paramount importance for a successful delivery of the MRI-directed diagnostic pathway for prostate cancer. This requires a global effort from our community and can be achieved by adhering to specific technical requirements for image acquisition (i.e. PI-RADS guidelines), by limiting the presence of common artefacts that affect MRI performance (i.e. patient preparation) and by using a standardised assessment of image quality (e.g. using PI-QUAL, and its future iterations).\

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