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Collaborative Review – Prostate Cancer

Can Clinically Significant Prostate Cancer Be Detected with Multiparametric Magnetic Resonance Imaging? A Systematic Review of the Literature

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Abstract

Context: Detection of clinically significant prostate cancer (PCa) is a major challenge. It has been shown that multiparametric magnetic resonance imaging (mpMRI) facilitates localisation of PCa and can help in targeting prostate biopsy.
Objective: To systematically review the literature to determine the diagnostic accuracy of mpMRI in the detection of clinically significant PCa.
Evidence acquisition: The Pubmed, Embase, and Cochrane Central Register of Controlled Trials (CENTRAL) databases were searched from January 1, 2000 to September 30, 2014, using the search criteria "prostate OR Pca OR PSA OR prostatic OR prostate cancer" AND "MR OR NMR OR NMRI OR MRI OR magnetic resonance OR ADC OR DWI OR DCE OR diffusion weighted OR dynamic contrast OR multiparametric OR MRSI OR MR spectroscopy". Two reviewers independently assessed 1729 records. Two independent reviewers assessed the methodologic quality using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) 2 tool.
Evidence synthesis: Twelve articles were eventually selected. Patients had a median age of 62–65 yr (range 39–83 yr), a median prostate-specific antigen (PSA) level of 5.1–13.4 ng/ml (range 1.2–228 ng/ml), and Gleason score of 6–10. Various definitions of clinical significance were used, mainly based on maximum cancer core length and grade at biopsy, number of positive cores, and PSA. Detection of clinically significant PCa using mpMRI ranged from 44% to 87% in biopsy-naïve males and men with prior negative biopsies using prostate biopsy or definitive pathology of a radical prostatectomy specimen as the reference standard. The negative predictive value for exclusion of significant disease ranged from 63% to 98%.
Conclusions: mpMRI is able to detect significant PCa in biopsy-naïve males and men with prior negative biopsies. The negative predictive value of mpMRI is important to the clinician because mpMRI could be used to rule out significant disease. This may result in fewer or no systematic or targeted biopsies in patients with PSA suspicious for prostate cancer.
Patient summary: We reviewed the diagnostic accuracy of multiparametric magnetic resonance imaging (mpMRI) for the detection of clinically significant prostate cancer (PCa). We conclude that mpMRI is able to detect significant PCa and may used to target prostate biopsies.

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1. Introduction

A major concern related to prostate cancer (PCa) screening and early detection is overdiagnosis and overtreatment of indolent disease. Strategies to reduce overdiagnosis are necessary, as are strategies to differentiate indolent from aggressive tumours [1].

The conventional diagnostic pathway in men with elevated serum prostate-specific antigen (PSA) levels and/or abnormal digital rectal examination consists of a random systematic transrectal ultrasound (TRUS)-guided prostate biopsy (PB) [2]. The main disadvantages are that (1) TRUS-guided PB misses a substantial proportion of significant PCa (approx. 20%) because of sampling errors, especially in the anterior part of the prostate gland [3,4], and (2) a high proportion of men are diagnosed with clinically insignificant disease, which may result in subsequent overtreatment.

Owing to its high soft-tissue contrast, high resolution, and ability to simultaneously image functional parameters, magnetic resonance imaging (MRI) provides the best visualisation of the prostate compared to other imaging methods. Over the past years, MRI use has shifted from staging purposes to detection and tumour localisation. PB based on MRI findings improves PCa detection over systematic TRUS-guided PB [5]. Functional techniques, such as diffusion-weighted MRI (DW-MRI), dynamic contrast-enhanced MRI (DCE-MRI), and/or MR spectroscopy imaging (MRSI) [6–10], in addition to conventional T2-weighted anatomical sequences (multiparametric MRI, mpMRI), have resulted in accurate PCa localisation [11–14] and allow image-guided targeted sampling to overcome the limitations of the traditional blind PB.

mpMRI detects both high-grade and larger tumours accurately, which means it may perform particularly well for detection of clinically significant disease [10]. Evidence is being gathered to identify cancers of significant volume. Moreover, these functional techniques may be used to differentiate between low- and intermediate/high-grade PCa [15–18]. These characteristics make MRI a potential tool for ruling out significant disease. The next step that will be taken is to identify cancers of significant grade (Gleason 4 or 5 component) independent of the volume. DW-MRI is the most promising technique for investigating not only tumour size but also aggressiveness [16].

The aim of the present study was to perform a systematic review of the literature to determine the diagnostic accuracy of mpMRI for the detection of clinically significant PCa.

2. Evidence acquisition

2.1. Search strategy

A literature search using the Medline and Embase databases, Cochrane reviews, and the Cochrane database of clinical trials was performed. The following inclusion criteria were used: humans; male gender; adult; English language and publication date from January 1, 2000 until September 30, 2014. The search terms used were "prostate OR PCa OR PSA OR prostatic OR prostate cancer" AND "MR OR NMR OR NMRI OR MRI OR magnetic resonance OR ADC OR DWI OR DCE OR diffusion weighted OR dynamic contrast OR multiparametric OR MRSI OR MR spectroscopy". Abstracts were reviewed for relevance to the defined review question. If it was not clear from the abstract whether the paper might contain relevant data, the full paper was assessed. Other significant studies cited in the reference lists of the selected papers were evaluated, as were studies published after the systematic search. Moreover, reports from meetings were also considered, but review articles and editorials were excluded from the analysis. The systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines [19].

2.2. Study selection

We screened all retrieved records and included studies in which prostate MRI was performed with at least two functional MRI techniques (DW-MRI, DCE-MRI, or MRSI) in addition to anatomical T2-weighted MRI to detect clinically significant PCa, with PB or definitive pathology of a radical prostatectomy (RP) specimen as the reference standard. We excluded studies with a sample size of less than 50 patients. Two reviewers performed the first screening of titles and abstracts to select eligible studies, and then independently evaluated the records. Quality assessment of the included studies was performed by two independent reviewers using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) tool for diagnostic accuracy studies [20]. Inter-reviewer agreement was assessed using the Cohen k coefficient. Any disagreement was discussed and resolved by consensus. A flowchart showing the numbers of papers identified and included or excluded at each stage is presented in Figure 1.

2.3. Data extraction

A standardised form was used to extract data on patient characteristics, technical characteristics of the MRI equipment and imaging protocols, definitions of clinically significant disease, and methodologic characteristics.

The following data were extracted: year of publication, number of patients, patient age, PSA level, Gleason score, previous prostate biopsies, field strength, MRI vendor, use of phased array coils, use of endorectal coils, lesions per patient, MRI sequence(s) used to define the target, T2-weighted acquisition parameters, DW-MRI acquisition parameters, DCE-MRI acquisition parameters, information on prior PB, reference standard (cognitive or MRI/TRUS fusion transrectal PB, transperineal template prostate mapping, or definitive pathology of RP specimens), patient enrolment, study design, blinding, region of interest (whole gland, index lesion, or sectors), scoring of mpMRI data, MRI criteria for PB, overall detection rate, and definition of clinically significant disease. The standards of reporting for MRI-targeted biopsy (START) criteria were used for data extraction [21].