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Review – Prostate Cancer

Magnetic Resonance Imaging–targeted Biopsy May Enhance the Diagnostic Accuracy of Significant Prostate Cancer Detection Compared to Standard Transrectal Ultrasound-guided Biopsy: A Systematic Review and Meta-analysis

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Abstract

Context: Multiparametric magnetic resonance imaging (MRI) of the prostate may improve the diagnostic accuracy of prostate cancer detection in MRI-targeted biopsy (MRI-TBx) in comparison to transrectal ultrasound-guided biopsy (TRUS-Bx).
Objective: Systematic review and meta-analysis of evidence regarding the diagnostic benefits of MRI-TBx versus TRUS-Bx in detection of overall prostate cancer (primary objective) and significant/insignificant prostate cancer (secondary objective).
Evidence acquisition: A systematic review of Embase, Medline, Web of Science, Scopus, PubMed, Cinahl, and the Cochrane library was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement. Identified reports were critically appraised according to the Quality Assessment of Diagnostic Accuracy Studies criteria. Only men with a positive MRI were included.
Evidence synthesis: The reports we included (16 studies) used both MRI-TBx and TRUS-Bx for prostate cancer detection. A cumulative total of 1926 men with positive MRI were included, with prostate cancer prevalence of 59%. MRI-TBx and TRUS-Bx did not significantly differ in overall prostate cancer detection (sensitivity 0.85, 95% confidence interval [CI] 0.80–0.89, and 0.81, 95% CI 0.70–0.88, respectively). MRI-TBx had a higher rate of detection of significant prostate cancer compared to TRUS-Bx (sensitivity 0.91, 95% CI 0.87–0.94 vs 0.76, 95% CI 0.64–0.84) and a lower rate of detection of insignificant prostate cancer (sensitivity 0.44, 95% CI 0.26–0.64 vs 0.83, 95% confidence interval 0.77–0.87). Subgroup analysis revealed an improvement in significant prostate cancer detection by MRI-TBx in men with previous negative biopsy, rather than in men with initial biopsy (relative sensitivity 1.54, 95% CI 1.05–2.57 vs 1.10, 95% CI 1.00–1.22). Because of underlying methodological flaws of MRI-TBx, the comparison of MRI-TBx and TRUS-Bx needs to be regarded with caution.
Conclusions: In men with clinical suspicion of prostate cancer and a subsequent positive MRI, MRI-TBx and TRUS-Bx did not differ in overall prostate cancer detection. However, MRI-TBx had a higher rate of detection of significant prostate cancer and a lower rate of detection of insignificant prostate cancer compared with TRUS-Bx.
Patient summary: We reviewed recent advances in magnetic resonance imaging (MRI) for guidance and targeting of prostate biopsy for prostate cancer detection. We found evidence to suggest that MRI-guided targeted biopsy benefits the diagnosis of prostate cancer.

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1. Introduction

Transrectal ultrasound-guided prostate biopsy (TRUS-Bx) has been the cornerstone of prostate cancer diagnosis. The introduction of prostate-specific antigen (PSA) testing led to the need for random (not targeted) systematic sampling of the whole prostate by ultrasound guidance. Although the systematic sextant biopsy protocol with six cores has been the standard procedure for many years [1], a meta-analyses of 68 studies showed that a more extended (laterally directed) scheme with 12 cores increased prostate cancer detection in men with suspicion of prostate cancer by a factor of 1.3 [2]. Further increasing the number of cores at initial biopsy did not appear to significantly improve the diagnostic rate [2–4].

For men undergoing initial biopsy with elevated PSA, prostate cancer detection rates are approximately 40–45% for the systematic 12-core TRUS-Bx [5,6]. Subsequent serial biopsy results following previous negative biopsies may detect prostate cancer, even after many previous biopsies [6,7]. In saturation biopsy studies, the false negative rate for 12-core TRUS-Bx following initial biopsy is 20–24% [6,7]. Attempts to reduce the false-negative rate by additional, anterior, and apical sampling have been only marginally successful [8,9] and result in oversampling of insignificant tumours. Another approach, transperineal template biopsy, may detect both significant and insignificant additional prostate cancer. Besides increased detection of insignificant cancers, other disadvantages are the requirement for general anaesthesia and an increase in morbidity risk [10,11].

Several magnetic resonance imaging–guided targeted biopsy (MRI-TBx) methods have been discussed for the diagnosis of prostate cancer in men with a positive PSA test result and/or positive digital rectal examination [12,13]. The potential of the MRI-TBx approach for improved detection of significant prostate cancer and reductions in unnecessary biopsies of insignificant or absent prostate cancer is still being explored. Therefore, we compared the prostate cancer detection rates of TRUS-Bx and MRI-TBx for diagnostic evaluation in men scheduled for biopsy. To this end we carried out a systematic review and meta-analysis of the recent literature.

2. Evidence acquisition

2.1. Objective

Our aim was to systematically evaluate the benefits of MRI-TBx versus TRUS-Bx for overall prostate cancer detection (primary objective) and significant versus insignificant prostate cancer detection (secondary objective).

2.2. Search strategy

The search strategy is described in detail in Supplementary File 1. In summary, for each database the search terms used were (“prostate tumour”) AND (“biopsy” OR “prostate biopsy”) AND (“nuclear magnetic resonance imaging” OR “nuclear magnetic resonance” OR “mri”) AND (“diagnostic test accuracy study” OR “sensitivity and specificity” OR “predictive value”). A critical review of Embase, Medline (OvidSP), Web of Science, Scopus, PubMed, Cinahl, and the Cochrane library was performed. The systematic literature search was conducted with the help of an expert information specialist (librarian) from the Medical Library, Erasmus University Medical Center. The search was updated to 23 May 2014.

2.3. Inclusion and exclusion criteria

Included studies focus on men of all age groups with suspected prostate cancer scheduled for transrectal prostate biopsy with increased PSA and/or positive digital rectal examination. We selected only studies applying a sequential sampling design for the two biopsy tests, MRI-TBx and TRUS-Bx, in the same man. Only studies with patient data comprising individual MRI-TBx and TRUS-Bx results for the same patient were selected to compare the two tests in the most objective manner. Consequently, all included men had a positive MRI. Men with a negative MRI did not undergo MRI-TBx. A positive MRI was defined as identification of a lesion suspicious for prostate cancer on the prostate MRI scan. A suspicious lesion was defined as $\geq$1 on a 3-point scale (low, moderate, high suspicion), or $\geq$3 on a 5-point scale (Likert or PIRADS), ranging from 1 (no suspicion) to 5 (high suspicion) according to the likelihood of significant prostate cancer being present [14–17].

The index test was defined as MRI-TBx following a positive MRI. MRI-TBx was defined as any transrectal biopsy guidance technique in which an MRI scan was used to determine the location of a suspicious target before biopsy.

We included only studies that compared MRI-TBx to a systematic TRUS-Bx, performed independently of the MRI results, taking cores from both lobes in a random but systematic order, with a range of 8–12 cores depending on prostate volume. Hence, the pivotal point in this review is that both tests were performed in the same patient.

We excluded unpublished data or abstracts because information that is needed to correctly assess the study quality and interpret the results was not available in abstracts. We excluded reports on men with already proven prostate cancer. We excluded reports on men with transperineal or saturation biopsies. Reports on TRUS-Bx with duplex, contrast-enhanced ultrasound, or elastography were also excluded.

2.4. Data collection and data extraction

We followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) process [18] for reporting included and excluded studies, with the recommended flow chart showing the numbers of papers identified and included or excluded at each stage (Fig. 1). Titles and 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. The references cited in all full-text articles were also assessed for additional relevant articles. The search was

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