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European Association of Urology

Platinum Priority – Review – Prostate Cancer

Editorial by XXX on pp. x–y of this issue

Comparing Three Different Techniques for Magnetic Resonance Imaging-targeted Prostate Biopsies: A Systematic Review of In-bore versus Magnetic Resonance Imaging-transrectal Ultrasound fusion versus Cognitive Registration. Is There a Preferred Technique?

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Article info

Article history:
Accepted July 22, 2016

Associate Editor:
James Catto

Keywords:
Diagnosis
Image guided biopsy
Meta-analysis
MRI
Prostate cancer
Systematic review

Abstract

Context: The introduction of magnetic resonance imaging-guided biopsies (MRI-GB) has changed the paradigm concerning prostate biopsies. Three techniques of MRI-GB are available: (1) in-bore MRI target biopsy (MRI-TB), (2) MRI-transrectal ultrasound fusion (FUS-TB), and (3) cognitive registration (COG-TB).
Objective: To evaluate whether MRI-GB has increased detection rates of (clinically significant) prostate cancer (PCa) compared with transrectal ultrasound-guided biopsy (TRUS-GB) in patients at risk for PCa, and which technique of MRI-GB has the highest detection rate of (clinically significant) PCa.
Evidence acquisition: We performed a literature search in PubMed, Embase, and CENTRAL databases. Studies were evaluated using the Quality Assessment of Diagnostic Accuracy Studies-2 checklist and START recommendations. The initial search identified 2562 studies and 43 were included in the meta-analysis.
Evidence synthesis: Among the included studies 11 used MRI-TB, 17 used FUS-TB, 11 used COG-TB, and four used a combination of techniques. In 34 studies concurrent TRUS-GB was performed. There was no significant difference between MRI-GB (all techniques combined) and TRUS-GB for overall PCa detection (relative risk [RR] 0.97 [0.90–1.07]). MRI-GB had higher detection rates of clinically significant PCa (csPCa) compared with TRUS-GB (RR 1.16 [1.02–1.32]), and a lower yield of insignificant PCa (RR 0.47 [0.35–0.63]). There was a significant advantage ($p = 0.02$) of MRI-TB compared with COG-TB for overall PCa detection. For overall PCa detection there was no significant advantage of MRI-TB compared with FUS-TB ($p = 0.13$), and neither for FUS-TB compared with COG-TB ($p = 0.11$). For csPCa detection there was no significant advantage of any one technique of MRI-GB. The impact of lesion characteristics such as size and localisation could not be assessed.

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http://dx.doi.org/10.1016/j.eururo.2016.07.041

Conclusions: MRI-GB had similar overall PCa detection rates compared with TRUS-GB, increased rates of csPCa, and decreased rates of insignificant PCa. MRI-TB has a superior overall PCa detection compared with COG-TB. FUS-TB and MRI-TB appear to have similar detection rates. Head-to-head comparisons of MRI-GB techniques are limited and are needed to confirm our findings.

Patient summary: Our review shows that magnetic resonance imaging-guided biopsy detects more clinically significant prostate cancer (PCa) and less insignificant PCa compared with systematic biopsy in men at risk for PCa.

1. Introduction

Prostate cancer (PCa) is the most common malignancy among European men [1]. PCa incidence is expected to increase due to prostate-specific antigen (PSA) testing and aging of the general population [1]. The introduction of PSA testing led to an increased PCa incidence, while mortality from PCa has decreased [2,3]. Disadvantages of PSA screening are the risks of overdiagnosis and overtreatment of clinically insignificant PCa [3].

The current standard technique for PCa detection is transrectal ultrasound-guided biopsy (TRUS-GB). Using TRUS-GB the prostate is randomly sampled for the presence of PCa, and has its limitations due to the inability of grey-scale ultrasonography to distinguish PCa from benign tissue [4,5]. Consequently, TRUS-GB is renowned for its low sensitivity and specificity for PCa. This is underlined by the fact that repeat TRUS-GB due to persisting clinical suspicion on PCa, leads to the diagnosis of PCa in 10–25% of cases following a prior negative biopsy [6,7]. Furthermore, Gleason grading in radical prostatectomy specimens demonstrates upgrading in 36% when compared with preoperative grading using TRUS-GB [8]. Developments of multiparametric MRI (mpMRI) techniques have increased the sensitivity of imaging for PCa [9–12]. According the European Society of Urogenital Radiology (ESUR) guidelines an mpMRI consists of T2-weighted images, dynamic contrast enhanced imaging, and diffusion weighted imaging [13]. Usage of a 3 Tesla (3-T) magnet has further enhanced resolution and quality of imaging compared with 1.5-T [13]. Clinical guidelines advise performing an mpMRI when initial TRUS biopsy results are negative but the suspicion of PCa persists [4].

A standardised method for mpMRI evaluation was developed in order to increase inter-reader reliability and meaningful communication towards clinicians [13]. The Prostate Imaging-Reporting and Data System (PI-RADS) classification was introduced in 2012 by the ESUR, and has recently been updated to version 2.0. [13–15]. It evaluates lesions within the prostate on each of the three imaging modalities (T2-weighted, diffusion weighted imaging, and dynamic contrast enhanced) using a 1–5 scale, and additionally each lesion is given an overall score between 1 and 5 predicting its chance of being a clinically significant cancer [13–15].

Classically the definition of clinically significant PCa (csPCa) was based on the Epstein criteria [16,17] and d'Amico classification [18,19]. These classifications are based on random TRUS-GB outcomes. Due to the introduction of target biopsy procedures the preoperative definition of csPCa has changed. For that reason a number of new definitions of csPCa have been proposed, though as yet none have been widely adopted [20–23].

Various strategies for targeted biopsy of lesions on MRI have been developed, and demonstrate increased detection rates of csPCa compared with TRUS-GB [24–28]. Currently no consensus exists on which strategy of targeted biopsy should be preferred. Existing strategies of MRI guided biopsy (MRI-GB) include: (1) in-bore MRI target biopsy (MRI-TB) which is performed in the MRI suite using real-time MRI guidance [26,28], (2) MRI-TRUS fusion target biopsy (FUS-TB) where software is used to perform a MRI and TRUS image fusion, which allows direct target biopsies of MRI identified lesions using MRI-TRUS fusion image guidance [29–32], (3) cognitive registration TRUS targeted biopsy (COG-TB) where the MRI is viewed preceding the biopsy, and is used to *cognitively* target the MRI identified lesion using TRUS guidance [33,34].

The aim of this systematic review is to answer the following questions. In men at risk for PCa (based on an elevated PSA [>4.0 ng/ml] and/or abnormal digital rectal examination):

- Does MRI-GB lead to increased detection rates of csPCa compared with TRUS-GB?
- Is there a difference in detection rates of csPCa between the three available strategies of MRI-GB?

2. Evidence acquisition

2.1. Search strategy

A search strategy was designed using the STARLITE methodology [35]. A comprehensive search of literature was performed. A range of the last 10 yr was used since mpMRI has evolved rapidly in the last decade, and literature dating further back is not considered useful for current practise. No other search limits were applied. The search terms used were "Prostate OR Prostatic Neoplasm" AND "Biopsy" AND "Magnetic Resonance Imaging OR Image-Guided Biopsy" (see Appendix 1 for the complete search query). The search was assisted by an information specialist on October 27, 2014 using the PubMed, Embase, and CENTRAL databases.

Please cite this article in press as: Wegelin O, et al. Comparing Three Different Techniques for Magnetic Resonance Imaging-targeted Prostate Biopsies: A Systematic Review of In-bore versus Magnetic Resonance Imaging-transrectal Ultrasound fusion versus Cognitive Registration. Is There a Preferred Technique? Eur Urol (2016), http://dx.doi.org/10.1016/j.eururo.2016.07.041