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Overview

Multiparametric Magnetic Resonance Imaging in the Diagnosis of Prostate Cancer: A Systematic Review

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Abstract

A systematic review was conducted to investigate the use of multiparametric magnetic resonance imaging (MPMRI) followed by targeted biopsy in the diagnosis of clinically significant prostate cancer (CSPC) and to compare it with transrectal ultrasound-guided (TRUS-guided) systematic biopsy in patients with an elevated risk of prostate cancer who are either biopsy-naive or who have a previous negative TRUS-guided biopsy. MEDLINE, PubMed and EMBASE (1997 to April 2014), the Cochrane Library and six relevant conferences were searched to find eligible studies. Search terms indicative of 'prostate cancer' and 'magnetic resonance imaging' with their alternatives were used. Twelve systematic reviews, 52 full texts and 28 abstracts met the preplanned study selection criteria; data from 15 articles were extracted. In patients with an elevated risk of prostate cancer who were biopsy-naive, MPMRI followed by targeted biopsy could detect 2–13% of CSPC patients whom TRUS-guided systematic biopsy missed; TRUS-guided systematic biopsy could detect 0–7% of CSPC patients whom MPMRI followed by targeted biopsy missed. In patients with an elevated risk of prostate cancer who had a previous negative TRUS-guided biopsy, MPMRI followed by targeted biopsy detected more CSPC patients than repeated TRUS-guided systematic biopsy in all four studies, with a total of 516 patients, but only one study reached a statistically significant difference. In patients with an elevated risk of prostate cancer who are biopsy-naive, there is insufficient evidence for MPMRI followed by targeted biopsy to be considered the standard of care. In patients who had a prior negative TRUS-guided systematic biopsy and show a growing risk of having CSPC, MPMRI followed by targeted biopsy may be helpful to detect more CSPC cases as opposed to a repeat TRUS-guided systematic biopsy.

Key words: Elevated risk; multiparametric magnetic resonance imaging (MPMRI); prostate cancer; systematic review; targeted biopsy; transrectal ultrasound-guided (TRUS-guided) systematic biopsy

Statement of Search Strategies Used and Sources of Information

The following resources were checked for existing systematic reviews published from 2010 to October 2013: National Guideline Clearinghouse, National Health and Medical Research Council, New Zealand Guidelines Group, American Society of Clinical Oncology (ASCO), National Institute for Health and Clinical Excellence (NICE), Scottish Intercollegiate Guidelines Network (SIGN), American Urological Association (AUA), American Society for Radiation Oncology (ASTRO), European Society of Radiotherapy and Oncology (ESTRO), European Association of Urology (EAU), Canadian Urological Association (CUA), American College of Radiology (ACR), European Society of Urogenital Radiology (ESUR), National Institute for Health Research and the Standards and Guidelines Evidence Directory of Cancer Guidelines (www.cancerview.ca/sage). MEDLINE, PubMed, EMBASE, the Cochrane library were searched from 1997 to 23 April 2014 for relevant existing systematic reviews and original studies. In addition, the proceedings of the meetings of ASCO, CUA, AUA, ASTRO, ESTRO and Radiological Society of North America were searched for related abstracts from 2011 to April 2014. The National

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Cancer Institute Clinical Trials Database was searched in April 2014 for relevant ongoing, unpublished or incomplete trials. The combined alternatives of 'prostate cancer' together with 'MRI' terms were used to search the above databases.

Introduction

Prostate cancer is the third leading cause of death in Canadian male cancer patients [1]. Although some low-risk prostate cancers grow slowly and may require little or no treatment, intermediate- or high-risk prostate cancers can be life-threatening. Considering this, early and accurate diagnosis for clinically significant prostate cancer (CSPC) in patients with an elevated risk is important to determine optimal management and thereby improve their quantity and/or quality of life. As transrectal ultrasound-guided (TRUS-guided) systematic biopsy does not sample specimens of the prostate in a specific imaged target, the technique can over-diagnose clinically insignificant prostate cancer or miss clinically significant lesions in patients at initial and repeat biopsies [2,3]. The template transperineal mapping biopsy or saturation biopsy technique should be more diagnostic than TRUS-guided systematic biopsy to detect CSPC because in that technique, the prostate is divided into $\geq$20 regions and a specimen is taken from each region [4]. However, for a walnut-sized prostate, the template transperineal mapping biopsy or saturation biopsy technique is more invasive and resource-intense than TRUS-guided systematic biopsy.

In the past few years there has been growing interest in the use of multiparametric magnetic resonance imaging (MPMRI) to localise CSPC. MPMRI techniques include T2-weighted imaging, diffusion-weighted imaging, dynamic contrast-enhanced T1-weighted imaging and/or proton spectroscopy; and imaging features from at least three of these above data sets are combined to determine the location of a cancer as part of the MPMRI examination. MPMRI followed by targeted biopsy means the biopsy is carried out directly at cancer-suspicious foci detected with MPMRI. It is unclear whether the use of MPMRI can improve the accuracy of the diagnosis in patients with an elevated risk of CSPC. Thus, the review authors of the MRI in Prostate Cancer Guideline Development Group in association with the Program in Evidence-Based Care of Cancer Care Ontario conducted a systematic review to address the following two research questions. The systematic review has been registered in the international prospective register of systematic reviews (www.crd.york.ac.uk/prospero).

Research question 1: For biopsy-naive patients with an elevated risk of prostate cancer (according to prostate-specific antigen [PSA] levels and/or nomograms): (i) Does MPMRI add value in detecting CSPC, positively change patient management or improve patient outcomes? (ii) Is MPMRI followed by targeted biopsy better than TRUS-guided systematic biopsy (at least eight cores) for the detection rate of CSPC and other outcomes mentioned in (i)?

Research question 2: For patients who had a previous negative TRUS-guided systematic biopsy (at least eight cores) with an elevated risk of prostate cancer (according to PSA levels and/or nomograms): (i) Does MPMRI add value in detecting CSPC, positively change patient management or improve patient outcomes? (ii) Is MPMRI followed by targeted biopsy better than repeated TRUS-guided systematic biopsy (at least eight cores) for the detection rate of CSPC and other above patient outcomes in (i)?

Materials and Methods

Literature Search

The following resources were checked for relevant existing systematic reviews that were published from 2010 to October 2013: National Guideline Clearinghouse, National Health and Medical Research Council, New Zealand Guidelines Group, American Society of Clinical Oncology (ASCO), National Institute for Health and Clinical Excellence (NICE), Scottish Intercollegiate Guidelines Network (SIGN), American Urological Association (AUA), American Society for Radiation Oncology (ASTRO), European Society of Radiotherapy and Oncology (ESTRO), European Association of Urology (EAU), Canadian Urological Association (CUA), American College of Radiology (ACR), European Society of Urogenital Radiology (ESUR), National Institute for Health Research and the Standards and Guidelines Evidence Directory of Cancer Guidelines (www.cancerview.ca/sage). MEDLINE, PubMed, EMBASE and the Cochrane library were searched from 1997 to 23 April 2014 for relevant existing systematic reviews or original studies. In addition, the proceedings of the meetings of ASCO, CUA, AUA, ASTRO, ESTRO and the Radiological Society of North America were searched for related abstracts from 2011 to April 2014 if they were accessible from their websites. The National Cancer Institute Clinical Trials Database was searched in April 2014 to find relevant ongoing, unpublished or incomplete trials. The combined alternatives of 'prostate cancer' together with 'MRI' search terms were used (see Appendix 1).

Study Selection Criteria and Protocol

Inclusion Criteria

(i) Full texts, abstracts that were randomised controlled trials (RCTs) or prospective studies that analysed $\geq$ 30 patients.
(ii) Patients should be those who had an elevated risk of prostate cancer (according to PSA levels and/or nomograms).
(iii) For diagnostic outcomes, reference standards should be postoperational pathological report, template

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