

# Clinical and prostate multiparametric magnetic resonance imaging findings as predictors of general and clinically significant prostate cancer risk: A retrospective single-center study

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## Abstract

**Background:** To evaluate the predictive values of Prostate Imaging Reporting and Data System version 2 (PI-RADS v2), prostate-specific antigen (PSA) level, PSA density (PSAd), digital rectal examination findings, and prostate volume, individually and in combination, for the detection of prostate cancer (PCa) in biopsy-naïve patients.

**Methods:** We retrospectively analyzed 630 patients who underwent transrectal systematic prostate biopsy following prostate multiparametric magnetic resonance imaging. A standard 12-core biopsy procedure was performed. Univariate and multivariate analyses were performed to determine the significant predictors of clinically significant cancer but not PCa.

**Results:** The median age, PSA level, and PSAd were 70 years, 6.6 ng/mL, and 0.18 ng/mL per mL, respectively. A total of 374 (59.4%) of 630 patients were biopsy-positive for PCa, and 241 (64.4%) of 374 were diagnosed with clinically significant PCa (CSPCa). The PI-RADS v2 score and PSAd were independent predictors of PCa and CSPCa. The PI-RADS v2 score of 5 regardless of the PSAd value, or PI-RADS v2 score of 4 plus a PSAd of <0.3 ng/mL per mL, was associated with the highest CSPCa detection rate (38.1%–82.1%). Instead, the PI-RADS v2 score of ≤3 and PSAd of <0.15 ng/mL per mL yielded the lowest risk of CSPCa.

**Conclusions:** The combination of the PI-RADS v2 score and PSAd could prove to be a helpful and reliable diagnostic tool before performing prostate biopsies. Patients with a PI-RADS v2 score of ≤3 and PSAd of <0.15 ng/mL per mL could potentially avoid a prostate biopsy.

**Keywords:** Prostate cancer; Prostate Imaging Reporting and Data System score; Multiparametric magnetic resonance imaging; Transrectal ultrasound; Prostate biopsy

## 1. Introduction

Prostate cancer (PCa) is the fifth leading cause of cancer-related death in men, with an estimated 307,000 deaths per annum, accounting for 6.6% of the total male cancer mortality in Europe.<sup>[1]</sup> Although PCa can display heterogeneous clinical behaviors, early detection can alter its natural history and disease mortality.<sup>[2]</sup> Prostate cancer diagnosis has historically relied on prostate-specific antigen (PSA), digital rectal examination (DRE), transrectal ultrasound (TRUS), and systematic TRUS-guided biopsy. These diagnostic

methods may be associated with the detection of indolent and clinically insignificant tumors, leading to overtreatment and increased morbidity.<sup>[3]</sup>

Transrectal ultrasound reported low sensitivity for PCa detection (0.17–0.57), and similarly, conventional TRUS-guided prostate biopsy achieved a PCa detection rate of 0.2 to 0.4.<sup>[4]</sup> Moreover, prostate biopsies are expensive and invasive and could be associated with severe complications.<sup>[5]</sup> In the last decade, prostate multiparametric magnetic resonance imaging (mpMRI) has emerged as a novel imaging technique for PCa detection, localization, staging, and treatment guidance, with specificity, sensitivity, and negative predictive value (NPV) of 0.88, 0.74, and 0.64 to 0.94, respectively.<sup>[6–7]</sup> With the aim to ensure standardization in mpMRI, the Prostate Imaging Reporting and Data System (PI-RADS) was developed in 2012 and revised in 2015 by the European Society of Urogenital Radiology and the American College of Radiology.<sup>[8]</sup> However, the use of the PI-RADS score has reported discordant results. The PI-RADS reported an NPV for PI-RADS ≤3 lesions of 0.98; nonetheless, the positive predictive value (PPV) for clinically significant PCa (CSPCa) was 0.48 to 0.58. As a result, despite a PI-RADS score of ≤3, CSPCa may have been missed.<sup>[9]</sup> Any additional stand-alone method that could improve the predictive performance of the PI-RADS score is worth considering, especially for dubious mpMRI or particular tumor localization.<sup>[10,11]</sup>

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# Magnetic Resonance Imaging In Prostate Cancer Clinical Potentials

**Paul A. Bottomley, John R. Griffiths**



## **Magnetic Resonance Imaging In Prostate Cancer Clinical Potentials:**

*MRI for Radiotherapy* Gary Liney, Uulke van der Heide, 2019-06-20 This book provides for the first time a unified approach to the application of MRI in radiotherapy that incorporates both a physics and a clinical perspective Readers will find detailed information and guidance on the role of MRI in all aspects of treatment from dose planning with or without CT through to response assessment Extensive coverage is devoted to the latest technological developments and emerging options These include hybrid MRI treatment systems such as MRI Linac and proton guided systems which are ushering in an era of real time MRI guidance The past decade has witnessed an unprecedented rise in the use of MRI in the radiation treatment of cancer The development of highly conformal dose delivery techniques has led to a growing need to harness advanced imaging for patient treatment With its flexible soft tissue contrast and ability to acquire functional information MRI offers advantages at all stages of treatment In documenting the state of the art in the field this book will be of value to a wide range of professionals The authors are international experts drawn from the scientific committee of the 2017 MR in RT symposium and the faculty of the ESTRO teaching course on imaging for physicists Machine Learning in Radiation

Oncology Issam El Naqa, Ruijiang Li, Martin J. Murphy, 2015-06-19 This book provides a complete overview of the role of machine learning in radiation oncology and medical physics covering basic theory methods and a variety of applications in medical physics and radiotherapy An introductory section explains machine learning reviews supervised and unsupervised learning methods discusses performance evaluation and summarizes potential applications in radiation oncology Detailed individual sections are then devoted to the use of machine learning in quality assurance computer aided detection including treatment planning and contouring image guided radiotherapy respiratory motion management and treatment response modeling and outcome prediction The book will be invaluable for students and residents in medical physics and radiation oncology and will also appeal to more experienced practitioners and researchers and members of applied machine learning communities **Focal Therapy in Prostate Cancer** Hashim Uddin Ahmed, Manit Arya, Peter R. Carroll, Mark

Emberton, 2011-12-27 This book comprehensively reviews the potential of focal therapy and discusses why the changing face of prostate cancer warrants a change in the way we treat men with the disease It deals with the mechanisms by which disease can be localized within the gland and then the different technologies used for focal ablation Bringing together eminent contributors in one accessible reference this book introduces focal therapy to all urologists oncologists and radiologists who are involved in the treatment of men with prostate cancer *Adaptive Radiation Therapy* X. Allen

Li, 2011-01-27 Modern medical imaging and radiation therapy technologies are so complex and computer driven that it is difficult for physicians and technologists to know exactly what is happening at the point of care Medical physicists

responsible for filling this gap in knowledge must stay abreast of the latest advances at the intersection of medical imaging an

**High-Resolution Neuroimaging** Ahmet Mesrur Halefoğlu, 2018-03-14 Dr Ahmet Mesrur Halefo lu mostly deals with

research fields in body imaging and neuroradiology with multidetector computed tomography and high resolution magnetic resonance imaging He has served as postdoctoral research fellow at Johns Hopkins Hospital Currently he is working as an associate professor of radiology in Istanbul Turkey He has more than 50 high impact factor publications and has written 3 book chapters He is a member of Turkish Society of Radiology and European Society of Radiology During the recent years there have been major breakthroughs in MRI due to developments in scanner technology and pulse sequencing These important achievements have led to remarkable improvements in neuroimaging and advanced techniques including diffusion imaging diffusion tensor imaging perfusion imaging magnetic resonance spectroscopy and functional MRI These advanced neuroimaging techniques have enabled us to achieve invaluable insights into tissue microstructure microvasculature metabolism and brain connectivity

*Exploring the Potential of PSMA-PET Imaging on Personalized Prostate Cancer Treatment* Constantinos Zamboglou,Xuefeng Qiu,Harun Ilhan,Trevor Royce,2022-03-04

*MR Perfusion, An Issue of Magnetic Resonance Imaging Clinics of North America, E-Book* Max Wintermark,Ananth Madhuranthakam,2023-11-28 In this issue of MRI Clinics guest editors Drs Max Wintermark and Ananth Madhuranthakam bring their considerable expertise to the topic of MR Perfusion Top experts in the field discuss all three MR perfusion techniques DSC DCE and ASL as well as provide separate articles on evaluation of gliomas breast cancer musculoskeletal prostate and heart Contains 13 relevant practice oriented topics including perfusion imaging for brain tumors dynamic susceptibility contrast DSC MR perfusion arterial spin labelling ASL MR perfusion MR perfusion imaging of prostate dynamic contrast enhanced DCE MR perfusion MR perfusion imaging for breast cancer and more Provides in depth clinical reviews on MR perfusion offering actionable insights for clinical practice Presents the latest information on this timely focused topic under the leadership of experienced editors in the field Authors synthesize and distill the latest research and practice guidelines to create clinically significant topic based reviews

**Bone Marrow MRI** Lia Angela Mouloupoulos,Vassilis Koutoulidis,2014-11-17 MRI provides the best means of imaging the bone marrow directly and of non invasively assessing its composition Normal age related bone marrow changes alterations related to red marrow reconversion and pathological bone marrow processes generally conform to certain patterns that reflect the underlying marrow changes and can be clearly recognized on MR images In addition to conventional pulse sequences advanced MRI techniques such as Dynamic Contrast Enhanced MRI and Diffusion Weighted Imaging depict marrow changes at the microvascular and cellular level respectively This book provides radiologists with in depth information on the MRI appearances of normal abnormal and treated marrow following a structured pattern based approach MRI findings for various diseases that affect the bone marrow particularly those of a malignant nature are presented in detail MRI pattern recognition not only offers a systematic approach to image interpretation and diagnosis but also has prognostic implications with regard to some disease entities Each chapter includes a wealth of high quality images together with Key Points summarizing the most important information In addition to radiologists practitioners with an

interest in hematology and oncology will find this textbook atlas to be a valuable resource for the latest clinically relevant advances in bone marrow imaging **MRI-Guided Focused Ultrasound Surgery** Ferenc A. Jolesz, Kullervo H.

Hynynen, 2007-09-26 MRI Guided Focused Ultrasound Surgery will be the first publication on this new technology and will present a variety of current and future clinical applications in tumor ablation treatment This source helps surgeons and specialists evaluate analyze and utilize MRI guided focused ultrasound surgery bridging the gap between phase 3 clinical tr

**Clinical Emergency Radiology** J. Christian Fox, 2017-03-16 This book is a highly visual guide to the radiographic and advanced imaging modalities such as computed tomography and ultrasonography that are frequently used by physicians during the treatment of emergency patients Covering practices ranging from ultrasound at the point of care to the interpretation of CT scan results this book contains over 2 200 images each with detailed captions and line art that highlight key findings Within each section particular attention is devoted to practical tricks of the trade and tips for avoiding common pitfalls Overall this book is a useful source for experienced clinicians residents mid level providers or medical students who want to maximize the diagnostic accuracy of each modality without losing valuable time *Handbook of Magnetic Resonance Spectroscopy In Vivo* Paul A. Bottomley, John R. Griffiths, 2016-12-19 This handbook covers the entire field of magnetic resonance spectroscopy MRS a unique method that allows the non invasive identification quantification and spatial mapping of metabolites in living organisms including animal models and patients Comprised of three parts Methodology covers basic MRS theory methodology for acquiring quantifying spectra and spatially localizing spectra and equipment essentials as well as vital ancillary issues such as motion suppression and physiological monitoring Applications focuses on MRS applications both in animal models of disease and in human studies of normal physiology and disease including cancer neurological disease cardiac and muscle metabolism and obesity Reference includes useful appendices and look up tables of relative MRS signal to noise ratios typical tissue concentrations structures of common metabolites and useful formulae About eMagRes Handbooks eMagRes formerly the Encyclopedia of Magnetic Resonance publishes a wide range of online articles on all aspects of magnetic resonance in physics chemistry biology and medicine The existence of this large number of articles written by experts in various fields is enabling the publication of a series of eMagRes Handbooks on specific areas of NMR and MRI The chapters of each of these handbooks will comprise a carefully chosen selection of eMagRes articles In consultation with the eMagRes Editorial Board the eMagRes Handbooks are coherently planned in advance by specially selected Editors and new articles are written to give appropriate complete coverage The handbooks are intended to be of value and interest to research students postdoctoral fellows and other researchers learning about the scientific area in question and undertaking relevant experiments whether in academia or industry Have the content of this handbook and the complete content of eMagRes at your fingertips Visit the eMagRes Homepage **MR-Guided Interventions, An Issue of Magnetic Resonance Imaging Clinics of North America 23-4** Clare M. Tempany, 2016-01-07 Guest editors Claire

Tempany and Tina Kapur review MR Guided Interventions in this important issue in MRI Clinics of North America Articles include MR sequences and rapid acquisition for MR guided interventions MR guided breast interventions role in biopsy targeting and lumpectomies MR guided passive catheter tracking for endovascular therapy MRgFUS update on clinical applications MR guided spine Interventions MR guided prostate biopsy Interventional MRI Clinic the Emory experience MR guided cardiac interventions MR guided functional neurosurgery MR guided active catheter tracking MR guided drug delivery MR guided thermal therapy for localized and recurrent prostate cancer MR neurography for guiding nerve blocks and its role in pain management MR guided gynecologic brachytherapy and more     Magnetic Resonance Imaging for Radiation Therapy Ning Wen, Yue Cao, Jing Cai, 2020-06-04     *Prostate MRI Essentials* Temel Tirkes, 2020-06-09 This book is a basic practical guide to performing and interpreting state of the art prostate MRI utilizing the latest guidelines in the field Prostate MRI has become one of the fastest growing examinations in the radiology practice and this demand has continuously increased within the past decade Since it is relatively new MRI of the prostate is predominantly being performed at academic institutions however there is a growing demand within the lower tier health care institutions to offer this examination to their patients This is an ideal guide for radiologists who want to enhance or initiate prostate MRI service for their referring clinicians and as a manual for technologists and those who are in training Prostate cancer is the second leading cause of cancer death in men exceeded only by lung cancer The best predictor of disease outcome lies with correct diagnosis which requires precise imaging and diagnostic procedures aided by prostate MRI Urologists medical oncologists and radiation oncologists all agree that multi parametric prostate MRI is essential for evaluation of prostate cancer However the technical aspects of prostate MR imaging are not as straightforward as for the other imaging modalities and constantly evolving Its small size presents a real challenge to the radiologist who needs to do the T2 and diffusion weighted images and perform a dynamic contrast enhanced sequence correctly These images may also need to be analyzed on an independent workstation Due to the absence of a current reference manual when a radiologist wants to establish a prostate imaging service he she needs to attend dedicated prostate MR workshops or dive into the literature search alone only to get more confused about what to do and how to do it With this book expert authors were asked to give clear guidance to those who want to enhance or initiate their prostate imaging service With this much needed concise practical guidance radiologists can perform and interpret multi parametric prostate MRI in a standardized fashion in concordance with PI RADS v2 1 that can be applicable to all available hardware platforms GE Philips Siemens Toshiba Additionally they can perform post processing for possible targeted biopsy and interpret post therapy and PET studies The book discusses imaging protocols planning and prescription and sequence parameters with representative images for each MRI sequence This handbook style practical manual can be used in the radiology reading room by those interpreting the MR exam as a reference as well as at the MRI scanner by the technologists as a guide Coverage of basic prostate anatomy pathology Urologists point of view MRI guided radiation

treatment planning and molecular imaging is also included Throughout the book authors will discuss basics pitfalls and provide tips in image acquisition and interpretation alongside several case examples **Clinical MR Imaging P.**

Reimer,P.M. Parizel,F.-A. Stichnoth,2006-05-11 This book offers practical guidelines for performing efficient and cost effective MRI examinations By adopting a practical protocol based approach the work flow in a MRI unit can be streamlined and optimized All chapters have been thoroughly reviewed and new techniques and figures are included There is a new chapter on MRI of the chest This book will help beginners to implement the protocols and will update the knowledge of more experienced users *The Great Prostate Hoax* Richard J. Ablin,Ronald Piana,2014-03-04 Every year more than a million men undergo painful needle biopsies for prostate cancer and upward of 100 000 have radical prostatectomies resulting in incontinence and impotence But the shocking fact is that most of these men would never have died from this common form of cancer which frequently grows so slowly that it never even leaves the prostate How did we get to a point where so many unnecessary tests and surgeries are being done In *The Great Prostate Hoax* Richard J Ablin exposes how a discovery he made in 1970 the prostate specific antigen PSA was co opted by the pharmaceutical industry into a multibillion dollar business He shows how his discovery of PSA was never meant to be used for screening prostate cancer and yet nonetheless the test was patented and eventually approved by the FDA in 1994 Now doctors and victims are beginning to speak out about the harm of the test and beginning to search for a true prostate cancer specific marker Quantitative Magnetic Resonance Imaging

Nicole Seiberlich,Vikas Gulani,Adrienne Campbell-Washburn,Steven Sourbron,Mariya Ivanova Doneva,Fernando Calamante,Houchun Harry Hu,2020-11-18 Quantitative Magnetic Resonance Imaging is a go to reference for methods and applications of quantitative magnetic resonance imaging with specific sections on Relaxometry Perfusion and Diffusion Each section will start with an explanation of the basic techniques for mapping the tissue property in question including a description of the challenges that arise when using these basic approaches For properties which can be measured in multiple ways each of these basic methods will be described in separate chapters Following the basics a chapter in each section presents more advanced and recently proposed techniques for quantitative tissue property mapping with a concluding chapter on clinical applications The reader will learn The basic physics behind tissue property mapping How to implement basic pulse sequences for the quantitative measurement of tissue properties The strengths and limitations to the basic and more rapid methods for mapping the magnetic relaxation properties T1 T2 and T2 The pros and cons for different approaches to mapping perfusion The methods of Diffusion weighted imaging and how this approach can be used to generate diffusion tensor maps and more complex representations of diffusion How flow magneto electric tissue property fat fraction exchange elastography and temperature mapping are performed How fast imaging approaches including parallel imaging compressed sensing and Magnetic Resonance Fingerprinting can be used to accelerate or improve tissue property mapping schemes How tissue property mapping is used clinically in different organs Structured to cater for MRI researchers and graduate students

with a wide variety of backgrounds Explains basic methods for quantitatively measuring tissue properties with MRI including T1 T2 perfusion diffusion fat and iron fraction elastography flow susceptibility enabling the implementation of pulse sequences to perform measurements Shows the limitations of the techniques and explains the challenges to the clinical adoption of these traditional methods presenting the latest research in rapid quantitative imaging which has the possibility to tackle these challenges Each section contains a chapter explaining the basics of novel ideas for quantitative mapping such as compressed sensing and Magnetic Resonance Fingerprinting based approaches Artificial Intelligence and MRI: Boosting Clinical Diagnosis Antonio Napolitano,Natalie Julie Serkova,Daniel Rodriguez Gutierrez,Oliver Diaz,2022-08-05 *Journal of the National Cancer Institute* ,1990 **PET/CT in Prostate Cancer** Gary Cook,2017-07-24 This pocket book explains the significant and well documented impact that PET CT can have on the management of prostate cancer through the provision of high quality evidence regarding function and structure Up to date information is supplied on the relevance of PET CT to diagnosis treatment planning and therapy including the emerging role of PET CT with PSMA Readers will also find clear explanation of the relation of the clinical and pathological background to imaging and the value of PET CT compared with conventional radiological imaging The book will be an excellent asset for referring clinicians nuclear medicine radiology physicians radiographers technologists and nurses who routinely work in nuclear medicine and participate in multidisciplinary meetings It is published within the Springer series Clinicians Guides to Radionuclide Hybrid Imaging which presents contributions from professionals worldwide who share a common purpose in promoting nuclear medicine as an important imaging specialty for the diagnosis and management of oncological and non oncological conditions



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