Improving the Diagnosis and Management of Prostate Cancer with the Incorporation of MRI

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NCI Comprehensive Cancer Center
A Cancer Center Designated by the National Cancer Institute

University of Maryland
Marlene and Stewart Greenebaum Comprehensive Cancer Center

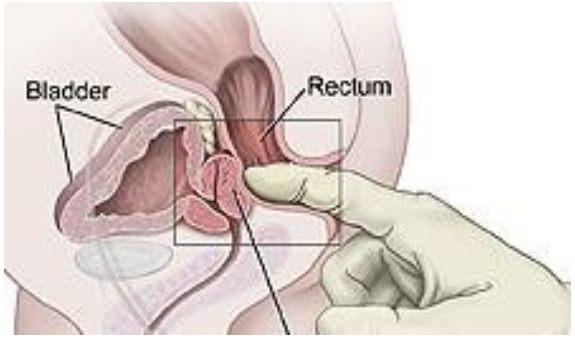
Purpose

- To provide an overview of current standard of care for prostate cancer
- To highlight key findings from interesting findings advancing how we diagnose prostate cancer
- Describe future work ongoing at UMMC Greenebaum Comprehensive Cancer Center in the management of prostate cancer

How is prostate cancer diagnosed?

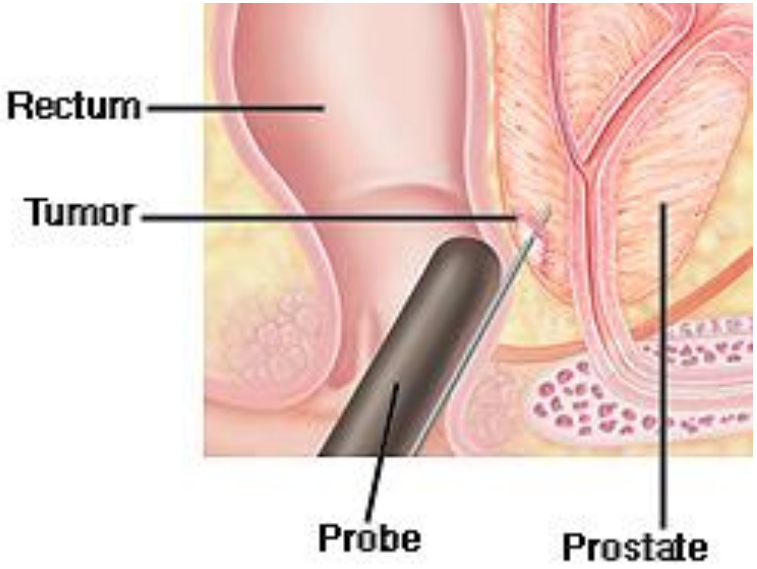
- PSA (prostate-specific antigen)
  - PSA produced in normal prostate and prostate cancer
  - Cancer makes much more than normal prostate
  - High levels raise suspicion for cancer

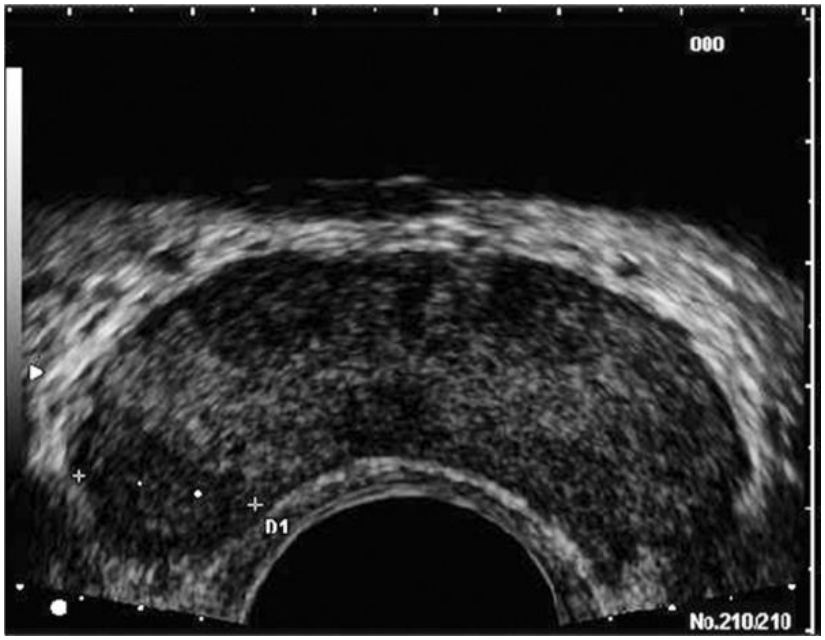
- Digital rectal exam
  - Doctor feels the surface of the prostate gland for bumps, hard spots, and any other abnormalities



Prostate biopsy

- Next step if PSA is high (>4ng/ml) or
- rectal exam is abnormal is prostate biopsy





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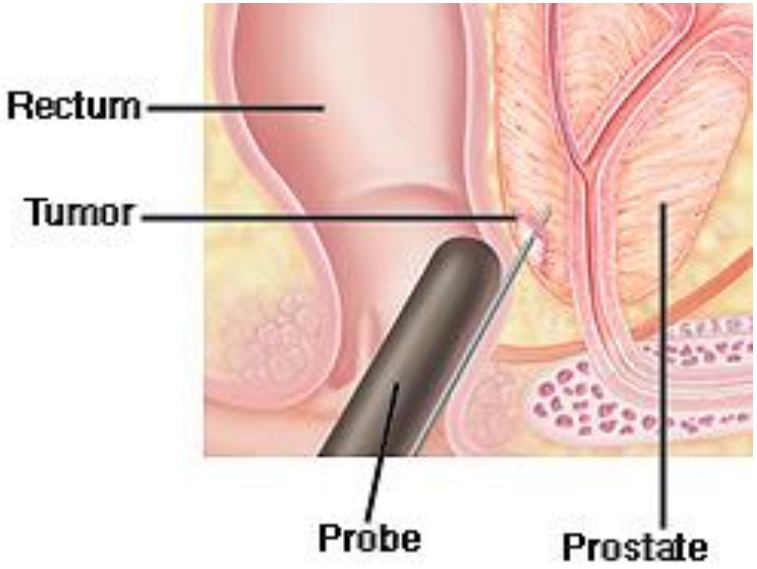

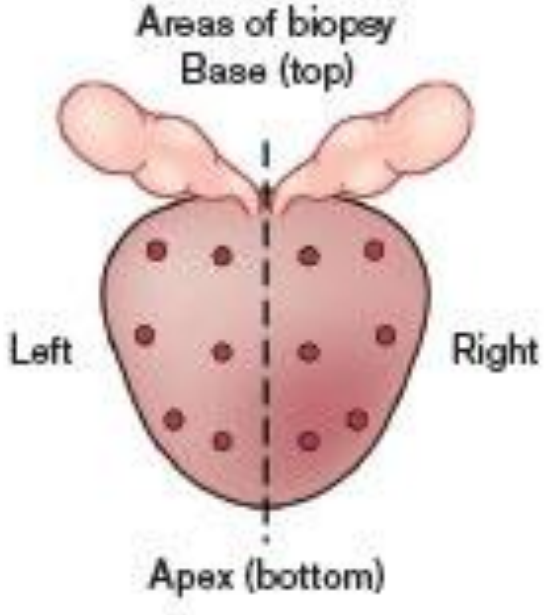

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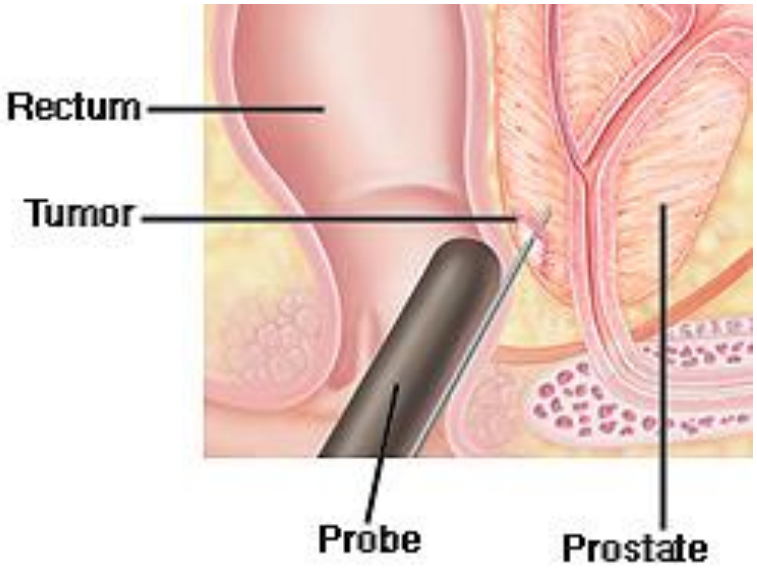

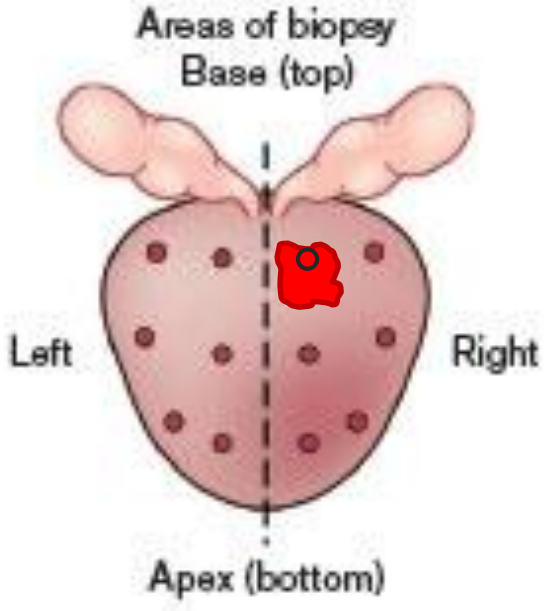

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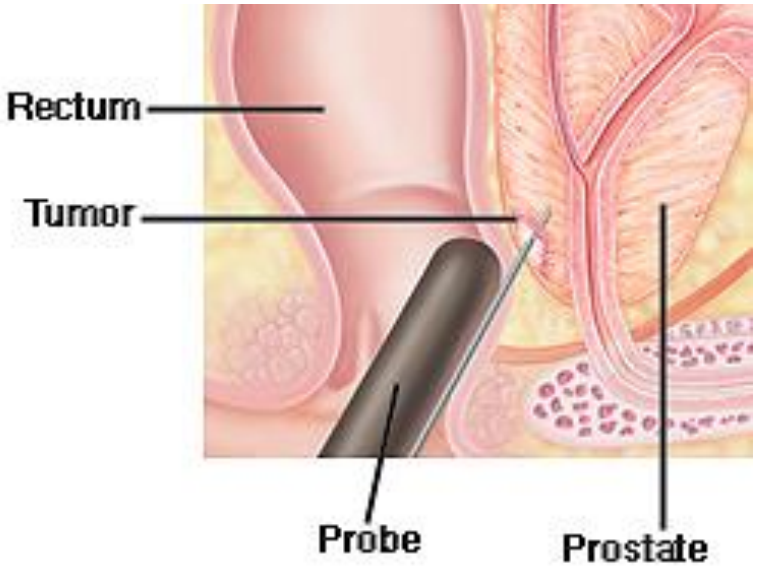
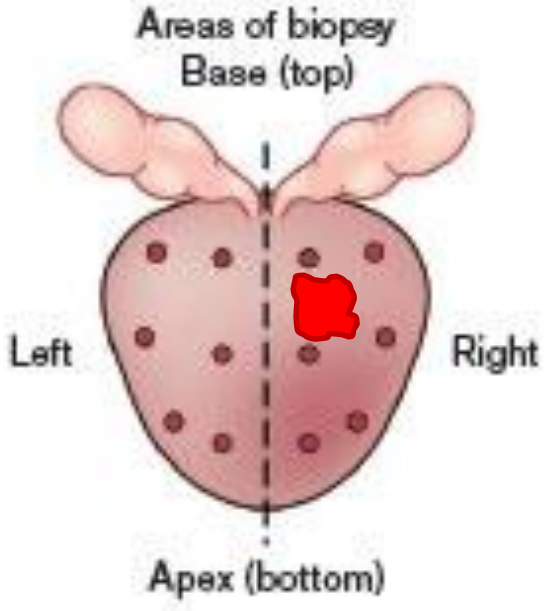
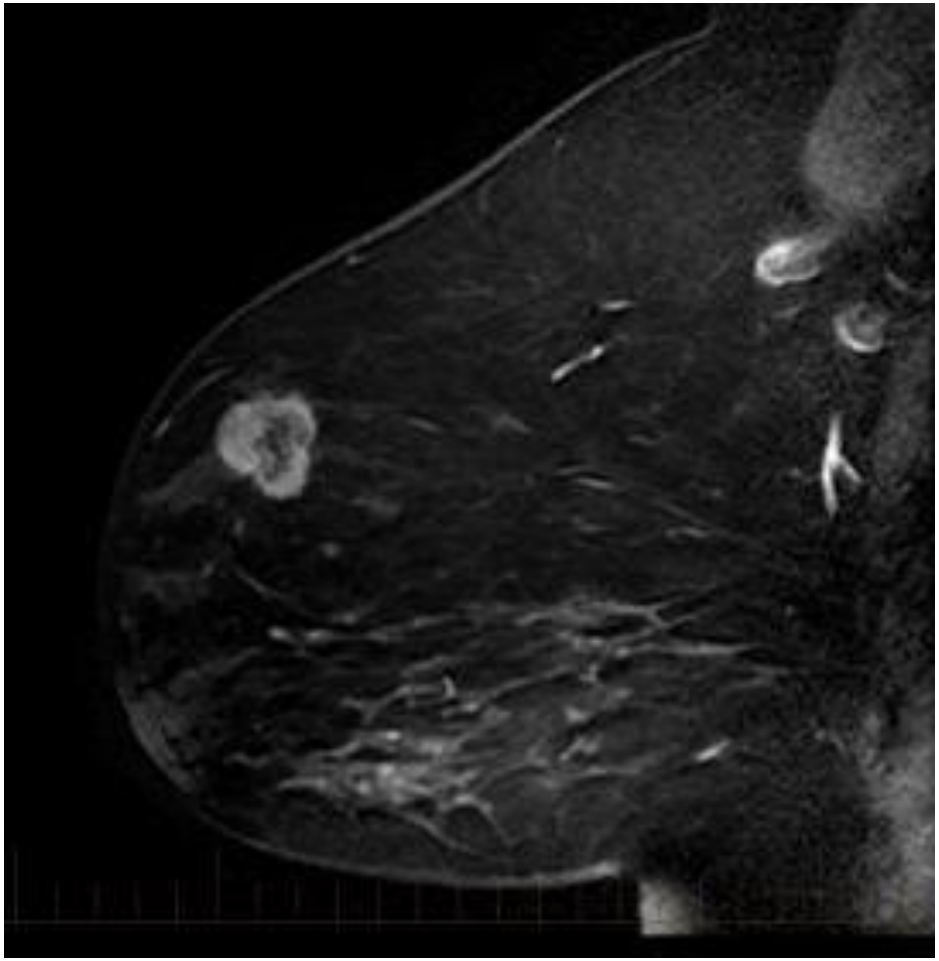




Why do we still rely on random sampling to diagnose prostate cancer?



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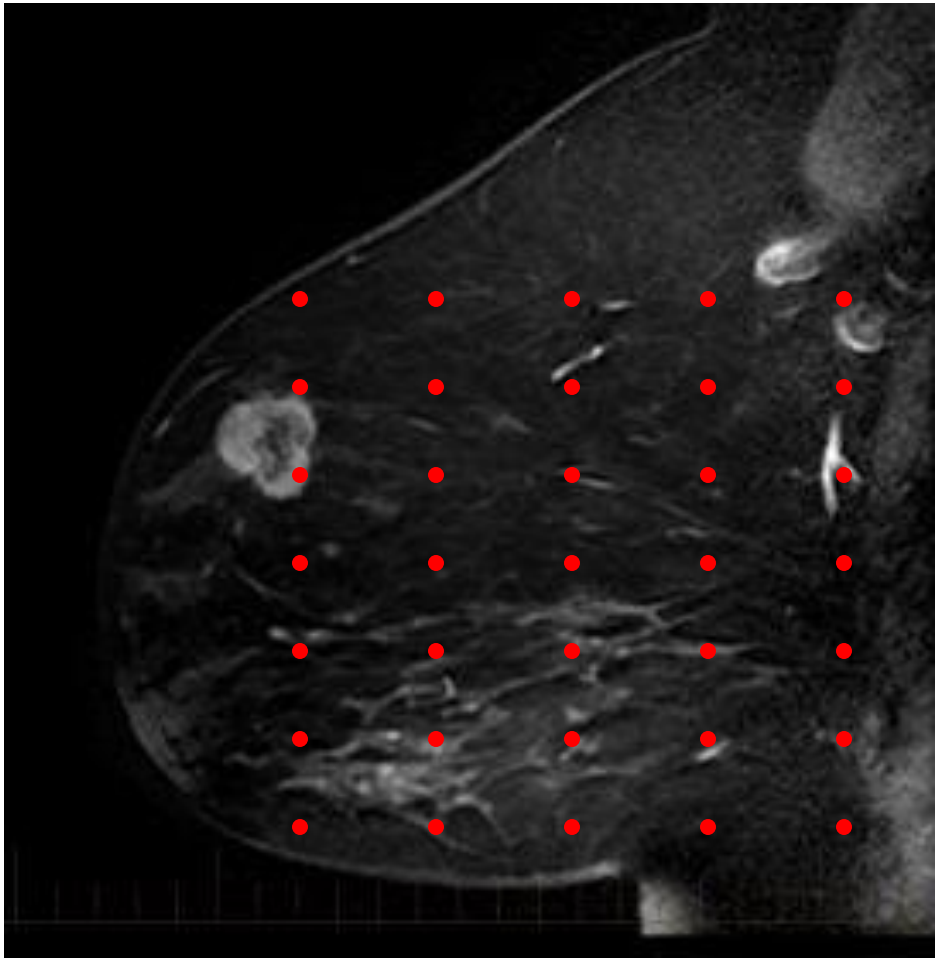

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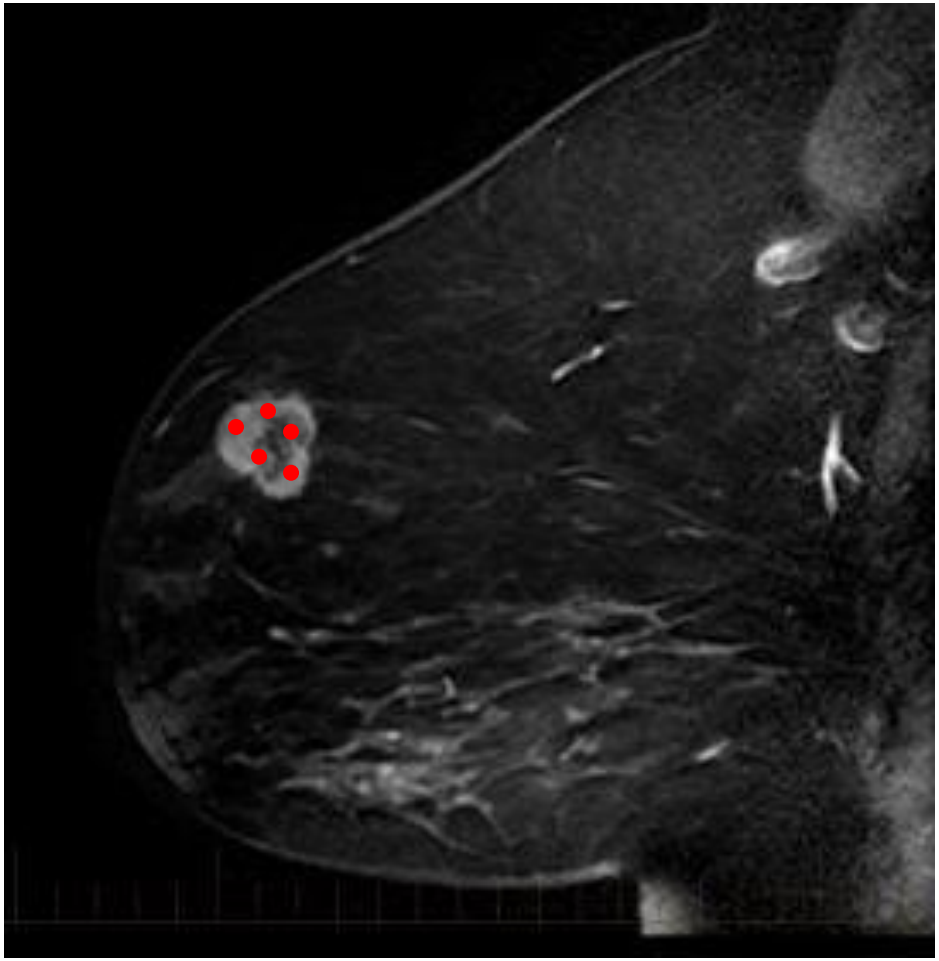
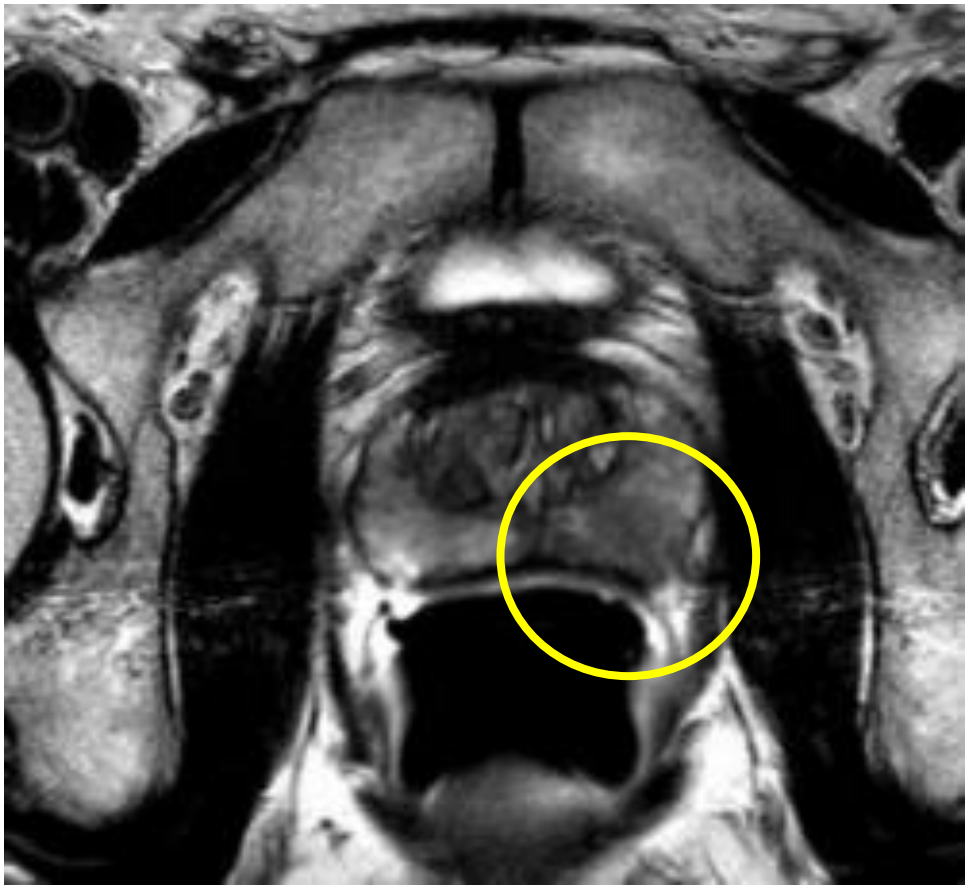
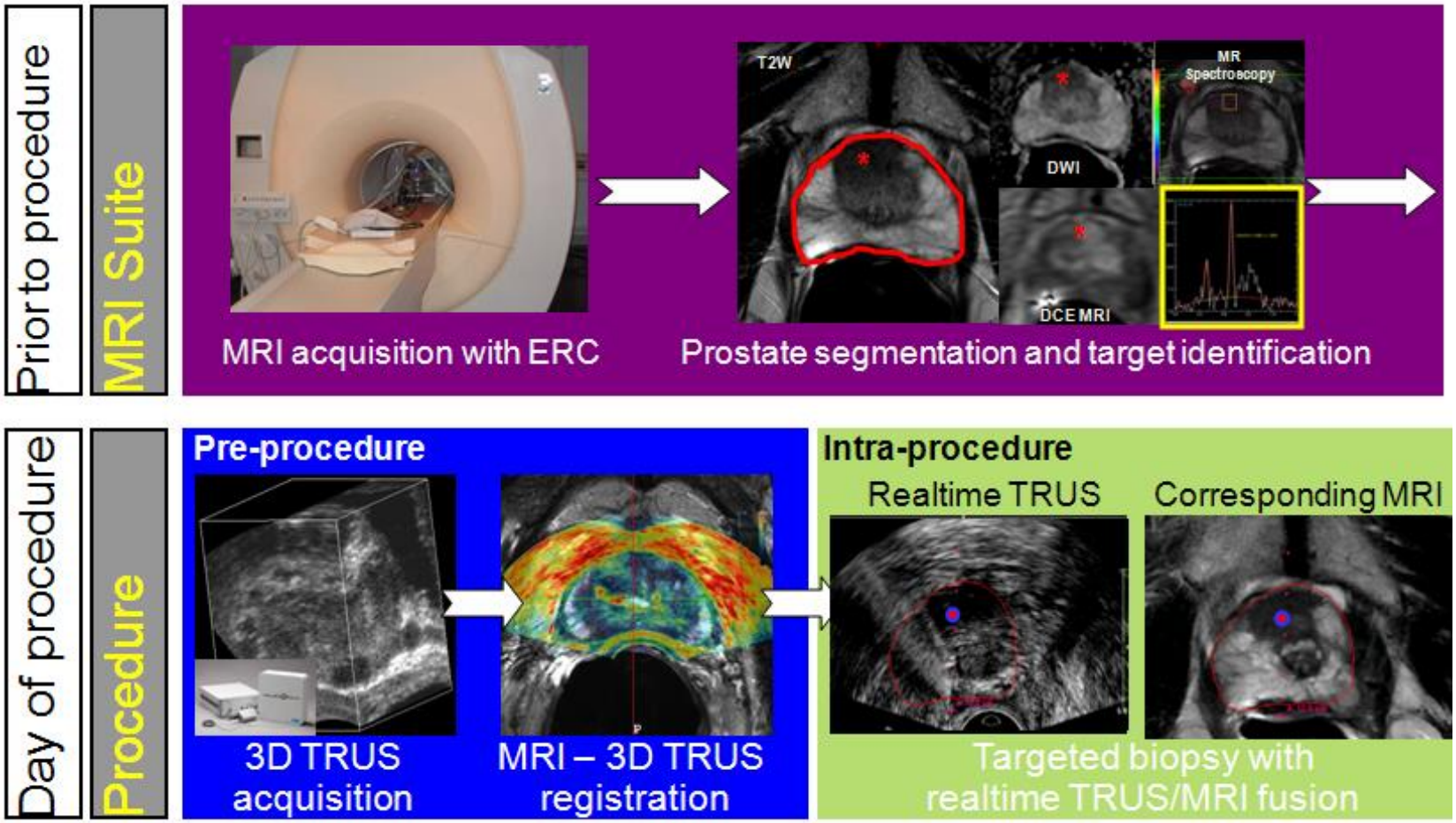


3Tesla Multiparametric Prostate MRI



MRI-Ultrasound Fusion Targeted Prostate Biopsies



Original Investigation

Comparison of MR/Ultrasound Fusion–Guided Biopsy With Ultrasound-Guided Biopsy for the Diagnosis of Prostate Cancer

M. Minhaj Siddiqui, MD; Soroush Rais-Bahrami, MD; Baris Turkbey, MD; Arvin K. George, MD; Jason Rothwax, BS; Nabeel Shakir, BS; Chinonyerem Okoro, BS; Dima Raskolnikov, BS; Howard L. Parnes, MD; W. Marston Linehan, MD; Maria J. Merino, MD; Richard M. Simon, DSc; Peter L. Choyke, MD; Bradford J. Wood, MD; Peter A. Pinto, MD

jama.com JAMA January 27, 2015 Volume 313, Number 4 391

- Fusion biopsy performed at the NIH from 2007-2014
- Analysis of 1003 men biopsied for suspicion of prostate cancer

Targeted biopsy versus standard biopsy demonstrated:

30% more high-grade prostate cancers diagnosed

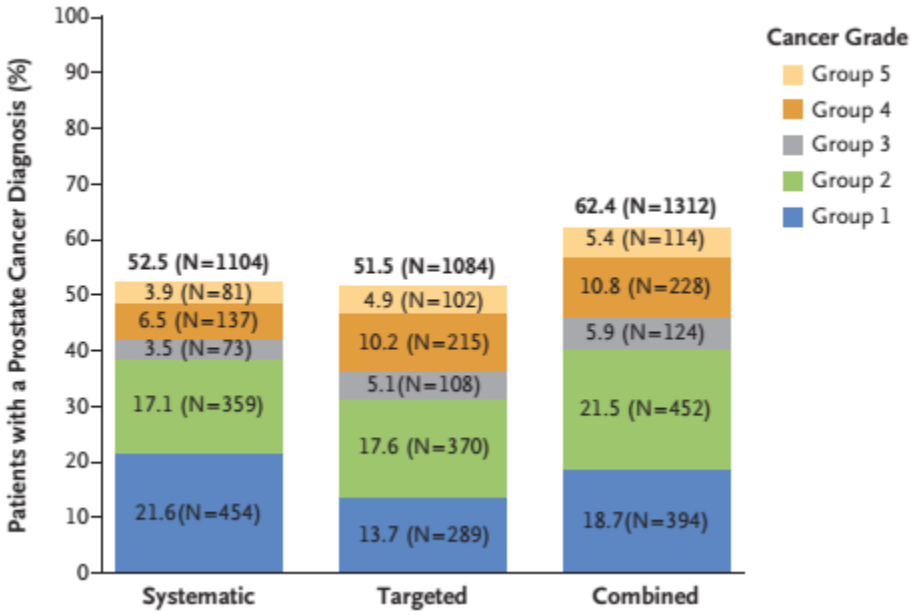
TRIO Study

The NEW ENGLAND JOURNAL of MEDICINE

MRI-Targeted, Systematic, and Combined Biopsy for Prostate Cancer Diagnosis

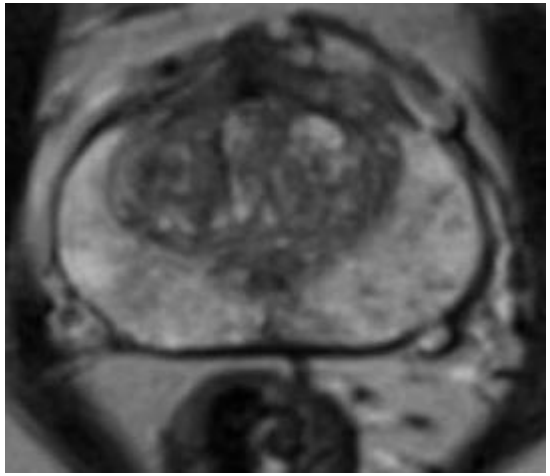
M. Ahdoot, A.R. Wilbur, S.E. Reese, A.H. Lebastchi, S. Mehralivand, P.T. Gomella, J. Bloom, S. Gurram, M. Siddiqui, P. Pinsky, H. Parnes, W.M. Linehan, M. Merino, P.L. Choyke, J.H. Shih, B. Turkbey, B.J. Wood, and P.A. Pinto

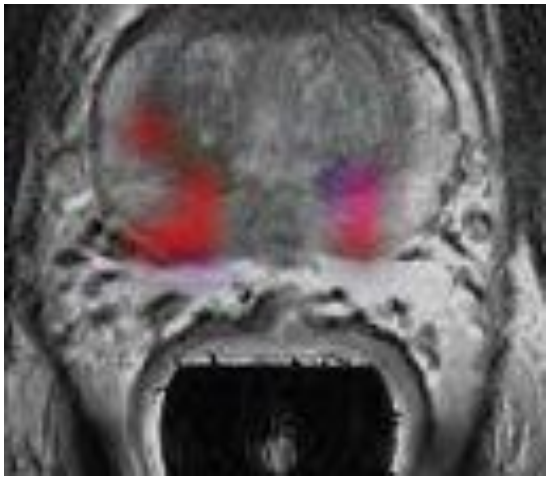
- Prospective study 2007-2019
- Analysis of 2103 men with prostate MRI and fusion biopsy
- Demonstrated optimal approach of Target + Systematic biopsy



Future Directions: Improvements in Imaging

- Targeting only as good as ability to place the correct target
  - Current approach uses anatomic landmarks
  - Future research examining integration of functional cues (such as local metabolic activity reflecting high tumor activity)





Metabolic Imaging

Rao Gullapalli, PhD, MBA

Professor

Diagnostic Radiology and Nuclear Med

Dirk Mayer, Dr. rer. nat.

Professor

Diagnostic Radiology and Nuclear Med

Center for Integration of Metabolic Imaging & Therapeutics (CIMIT)

- Major UMMC Investment: GE SpinLab Hyperpolarizer
  - New technology located in very few centers in the country
  - University of Maryland is one of them

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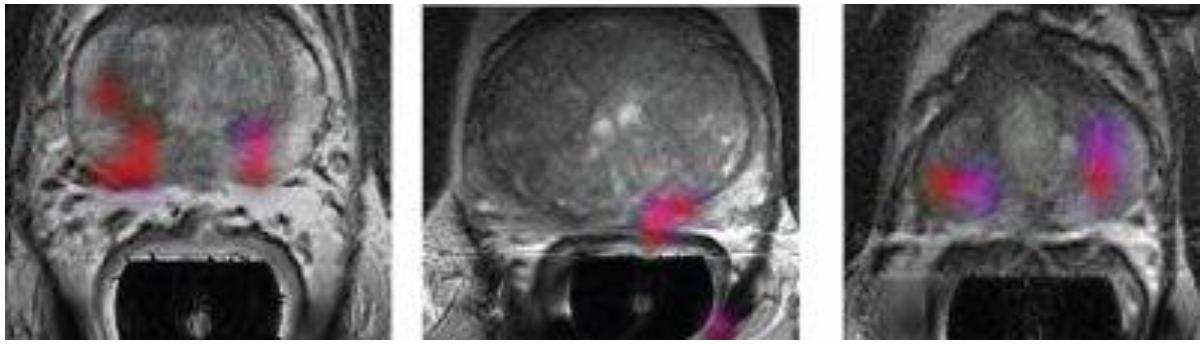
Diagnostic Radiology and Nuclear Med

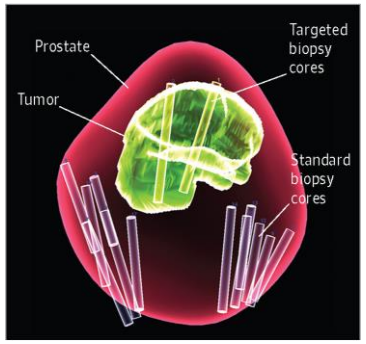
- Major UMMC Investment: GE SpinLab Hyperpolarizer
  - Allows for Metabolic Imaging using heavy carbon isotope (^{13}C) labeled compounds
  - Animal studies ongoing, implementing processes at UMMC to perform scans in humans **(Target first human studies January 2021)**



Metabolic Imaging Trial

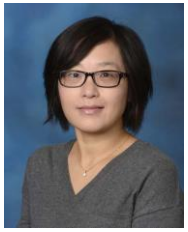
- Patient undergoes Metabolic MRI

Metabolically active targets in the prostate identified



Targeted biopsy of metabolically active lesions

Metabolic Characterization



Yuji Zhang, PhD

Associate Professor

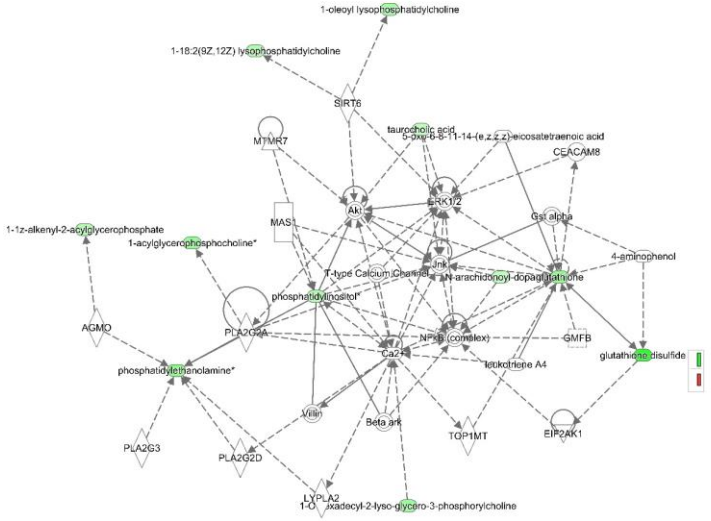
Epidemiology (Translational Bioinformatics)

Amrita Cheema, PhD

Professor, Co-Director

Proteomics and Metabolomics (*Georgetown)*

- Multi-Omics: Genomic and Metabolomic pathway analysis
  - Examining gene expression and untargeted metabolic expression for common pathways of up- and down-regulation
  - Candidate pathways:
    - Glucose Metabolism
    - Fatty Acid
    - Glutamine
    - Arginine



Dietary Metabolic Intervention

Adeel Kaiser, MD

Assistant Professor

Radiation Oncology

Chris D'Adamo, PhD

Associate Professor

Family and Community Medicine

Center for Integrative Medicine

- Fatty acid metabolism is important for prostate cancer proliferation
- Pilot study to examine if alteration of host metabolism can affect the tumor
- Ketogenic diet intervention (very-low carbohydrate, high fat, moderate protein)

12 men with prostate cancer on active surveillance

Initiate Ketogenic diet

diverts host metabolism from glycolysis to lipid metabolism

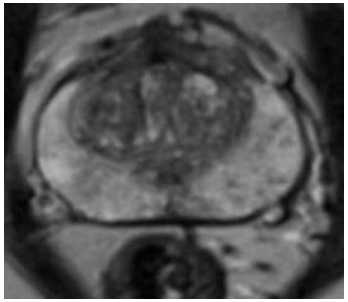
Examine effect in tissue, blood, and overall patient health (BMI, quality of life)

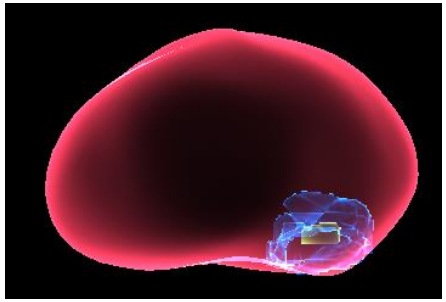
MID-ATLANTIC NORC
NUTRITION OBESITY RESEARCH CENTER

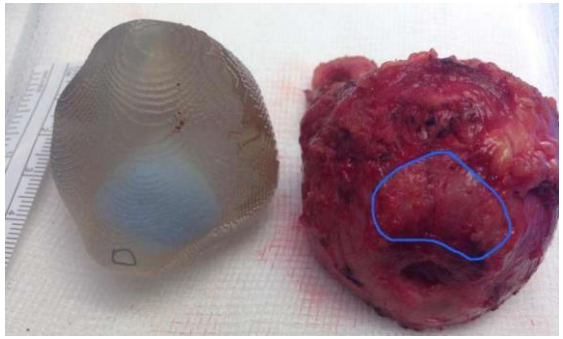
3D printing and virtual reality overlay to assist surgical planning

Jeff Hirsch, MD

Assistant Professor of Diagnostic Radiology







- Patient undergoes preoperative MRI

3D Model of the prostate is created from MRI and printed using 3D printer

3D Model used intraoperative to assist with resection of prostate and attention to tumor margins

3D printing and virtual reality overlay to assist surgical planning

Axel Krieger, PhD

Assistant Professor of Mechanical Engineering

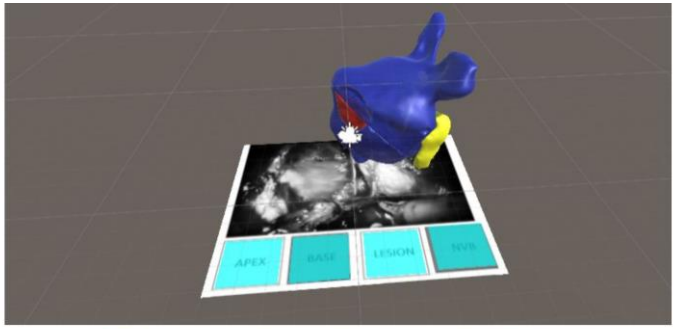
Clark School of Engineering, UM College Park

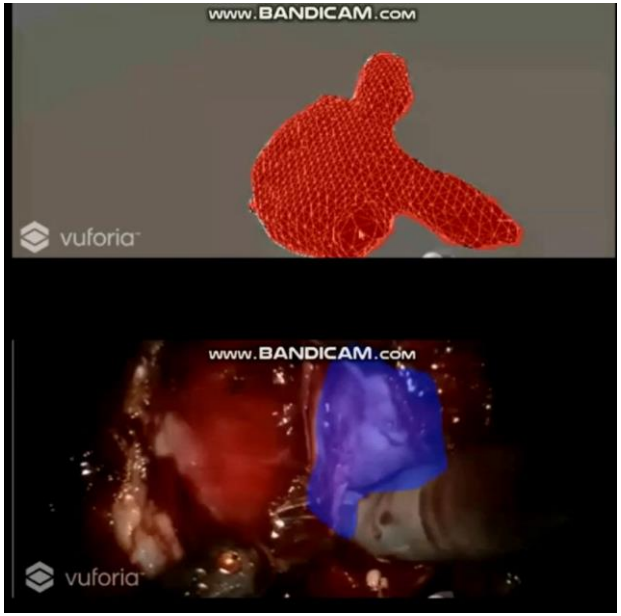
Amelia Wnorowski, MD

Assistant Professor of Diagnostic Radiology

Capstone Design project:

Christian Haryanto, Anjana Hevaganinge, Hannah Horng, Madeleine Noonan-Shueh





Take away points

- MRI can detect regions of concern for prostate cancer
- MRI/US fusion guided biopsies more reliably can sample the prostate for detection of significant cancer
- The role of MRI guided staging and treatment has promise but needs further development
- Future innovations, such as metabolic MRI with hyperpolarized C13 compounds, may further augment applications of imaging for prostate cancer management

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