Canon

Case Report

Prostate MRI

Experiences on wide-bore 3T

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“Since we have been using the Canon 3T MRI for mpMRI of the prostate we have had excellent results in detecting significant prostate cancers. Our patients like the wide bore and NOT having to use an endorectal coil. Our urologists are very pleased with our results and tell us we are making a substantial impact on the care of their patients, in particular those on active surveillance. Our volume continues to increase. Using MRI-US fusion to guide biopsies has improved detection rates with several patients with negative random biopsies having significant prostate cancers when image guided biopsies were performed.”

—Dr. Richard G. Barr MD, Ph.D., FACR, FSRU, President, Radiology Consultants Inc., Youngstown, Ohio

Dr. Richard G. Barr, MD, Ph.D. is a passionate advocate for the use and dissemination of MRI as one of the main imaging modality in the Prostate Cancer care spectrum. He is the Editor-in-Chief for the Journal of Ultrasound in Medicine. He is also a Professor at Northeastern Ohio Medical University and Youngstown State University. Dr. Barr has published numerous articles, is an invited reviewer of many high-impact journals and provides various lectures worldwide. Dr. Barr's research has been highlighted in Newsweek, Time, and Reader's Digest.

“The use of multi-parametric MRI followed by MRI fusion guided prostate biopsy has significantly improved our practices with early detection of clinically meaningful prostate cancer. Our patients now are able to have earlier access to treatment because of early and accurate detection.”

—Dr. Nicholas R. Styn MD, N.E.O. Urology Associates Inc., Boardman, Ohio

Dr. Nicholas R. Styn, MD is a board-certified urologist with extensive experience on prostate cancer. At his practice, Dr. Styn uses the MRI prostate findings as an important diagnostic tool for individualized patient care and disease management. He is an active member of the American Urological Association and the Endourological Society and was recognized by the International Alpha Omega Alpha Medical Honor Society.

Introduction

Prostate cancer is the most common cancer in America men after skin cancer. It is also the second leading cause of cancer death, behind lung cancer, in this population.[1] According to the American Cancer Society Cancer Facts & Figures report, 164,690 new cases of prostate cancer will be diagnosed in the US during 2018 and about 29,430 deaths will be caused by prostate cancer.[1]

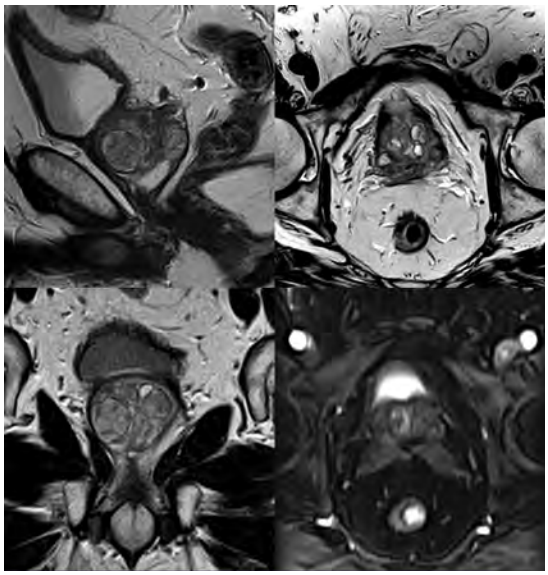
One of the most common tools used for screening is the prostate-specific antigen (PSA) blood test. Together with the digital rectal examination (DRE), PSA can help to diagnose prostate cancer even before the onset of symptoms. If either test has abnormal results, additional tests will be prescribed to confirm the diagnosis and further treatment planning. In recent years, prostate MRI has been considered an excellent tool to determine the presence, aggressiveness, and extension of prostate disease, due to its capabilities of combining high-resolution anatomic images with functional imaging.

In our institution, our routine multiparametric MRI (mpMRI) prostate is performed on a Canon 3T wide bore MRI system with phased-array coils placed around the pelvis. No endorectal coil is used and we follow the PI-RADS® v2 protocol and analysis recommendations. The images include T1-weighted, T2-weighted, diffusion-weighted imaging with ADC (b-values 50, 800 and 1600) and multiphase dynamic images at 7 sec/phase for 3 minutes. Additionally, fat-saturated post-contrast images of the pelvis are obtained and all data is further analyzed using Computer Aided Detection software.

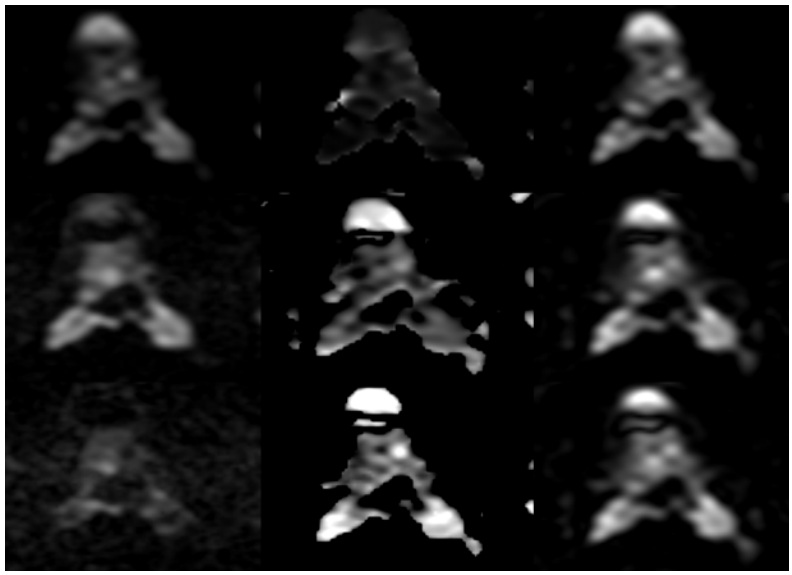
Case 1

History: The 68-year-old male patient presented for a follow-up Prostate MRI of a known right base prostate cancer. The patient has a history of previous transrectal ultrasonography (TRUS) biopsy 2 years before when he was diagnosed with a malignant neoplasm of the right base of the prostate (Gleason 3+4) but decided for no treatment and for active surveillance at that time. He had a normal digital rectal exam and his PSA was 2.52 ng/ml at the time of diagnosis and had remained relatively stable. He had a mpMRI one year prior which demonstrated a PI-RADS 4 lesion in the right base at the site of a positive biopsy.

Latest Imaging Findings: The prostate gland measures 5.7 cm x 4.2 cm x 4.9 cm. This corresponds to a prostate volume of 61 grams. There is enlargement of the transitional zone with circumscribed hypointense/heterogeneous encapsulated nodule(s) consistent with BPH (Benign Prostatic Hyperplasia).



Sag T2 (upper left), Ax T2 (upper right), Cor T2 (lower left) Ax Dynamic (lower right)



Axial DWI, ADC and IsoDWI (b=50) (upper row); (b=800) (middle row) and (b=1600) (lower row)

Lesion Number	Sector	Size (mm)	T2WI PI-RADS (1-5/X)	DWI PI-RADS (1-5/X)	DCE (+/-)	EPE (Y/N)	PI-RADS v2 FINAL (1-5)
1	RT BASE TZ	14	4	4	-	N	4

The transitional zone (TZ) demonstrates one identifiable abnormal T2W heterogeneous signal lesion with obscured margins or lenticular/non-circumscribed, homogeneous, at least moderately T2W hypointense lesion. No extraprostatic extension (EPE) is seen.

The peripheral zone (PZ) demonstrates no identifiable focal mildly/moderately hypointense lesions on ADC with isointense/mildly hyperintense signal on high b-value DWI or lesions focal markedly hypointense on ADC and markedly hyperintense on high b-value DWI. No extraprostatic extension (EPE) is seen.

No TZ or PZ lesions with focal dynamic contrast enhancement including earlier than or contemporaneously enhancing with adjacent tissues on early wash-in phases.

The prostate anatomic capsule is intact. The seminal vesicles are intact. No peri-prostatic or iliac chain lymphadenopathy noted. Remaining soft tissues are unremarkable. Visualized bone marrow signal is unremarkable.

Diagnosis: No change since the prior exam. PI-RADS 4 lesion on right base is unchanged. No new PI-RADS 3 or higher lesion was found.

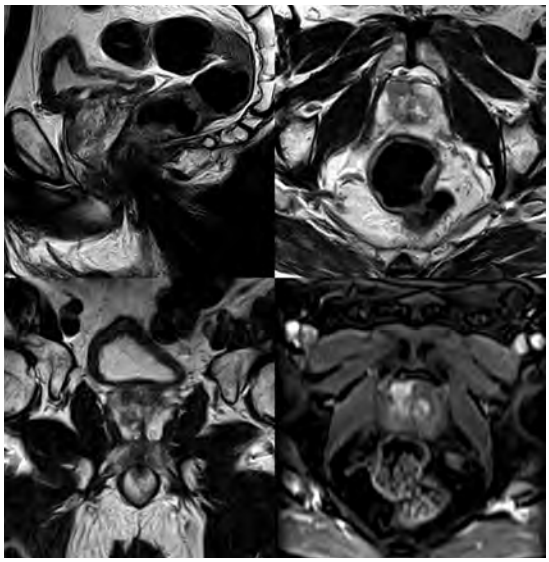
PI-RADS v2 FINAL SCORE: 4 - High (clinically significant cancer is likely to be present). As there was no change in the MRI patient remained on active surveillance. His PSA one year following this MRI remained stable at 2.65 ng/ml.

Case 2

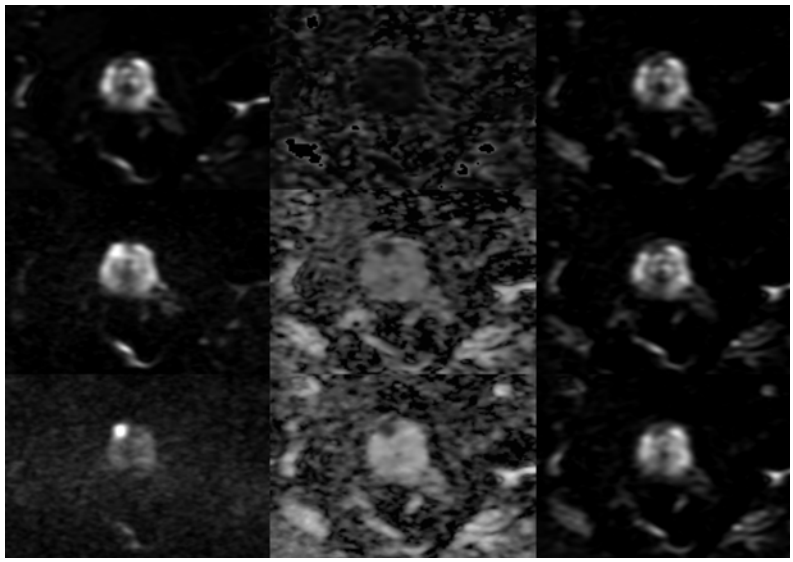
History: The 66-year-old male patient presented for a Prostate MRI to investigate causes for elevated PSA of 11.1 ng/ml. Patient's medical history includes two previous TRUS biopsies, with the most recent biopsy being negative.

Latest Imaging Findings: The prostate gland measures 5.0 cm x 3.6 cm x 4.4 cm. This corresponds to a prostate volume of 42 grams. There is enlargement of the transitional zone with circumscribed hypointense/heterogeneous encapsulated nodule(s) consistent with BPH.

The transitional zone (TZ) demonstrates a 1.3 cm in the anterior mid transitional zone identifiable abnormal T2W heterogeneous signal lesion with obscured margins or lenticular/non-circumscribed, homogeneous, at least moderately T2W hypointense lesion. This lesion is also markedly bright on diffusion-weighted images. This shows marked enhancement on early arterial phase contrast. No extraprostatic extension (EPE) is seen.



Sag T2 (upper left), Ax T2 (upper right), Cor T2 (lower left) Ax Dynamic (lower right)



Axial DWI, ADC and IsoDWI (b=50) (upper row); (b=800) (middle row) and (b=1600) (lower row)

Lesion Number	Sector	Size (mm)	T2WI PI-RADS (1-5/X)	DWI PI-RADS (1-5/X)	DCE (+/-)	EPE (Y/N)	PI-RADS v2 FINAL (1-5)
1	RT TZ and MID	13	4	4	+	N	4

The peripheral zone (PZ) demonstrates no identifiable focal mildly/moderately hypointense lesions on ADC with isointense/mildly hyperintense signal on high b-value DWI or lesions focal markedly hypointense on ADC and markedly hyperintense on high b-value DWI.

The prostate anatomic capsule is intact. The seminal vesicles are intact. There is diffuse bladder wall thickening consistent with bladder outlet obstruction from BPH. No peri-prostatic or iliac chain lymphadenopathy noted. Remaining soft tissues are unremarkable. Visualized bone marrow signal is unremarkable.

Diagnosis: A 13 mm right mid anterior transitional zone lesion which is low signal on T2 shows marked diffusion abnormality and marked early enhancement highly suspicious for a neoplasm.

PI-RADS v2 FINAL SCORE: 4 - High (clinically significant cancer is likely to be present). The patient was notified of the concerning findings on MRI and was counseled to undergo MRI fused prostate biopsy. He declined the procedure and has not returned for follow up or routine monitoring.

Case 3

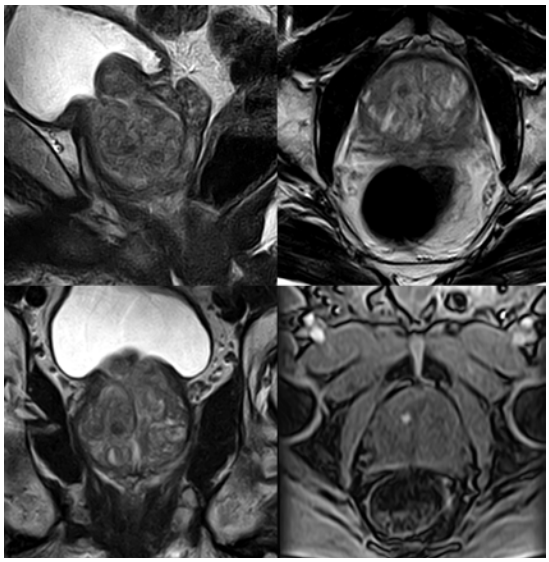
History: The 74-year-old male patient presented for a Prostate MRI to investigate elevated PSA of 6.31 ng/ml increased from 5.5 ng/ml in the year prior. Patient's medical history includes a previous negative biopsy.

Latest Imaging Findings: The prostate gland measures 6.5 cm x 5.3 cm x 7.2 cm. This corresponds to a prostate volume of 130 grams. There is enlargement of the transitional zone with circumscribed hypointense/heterogeneous encapsulated nodule(s) consistent with BPH.

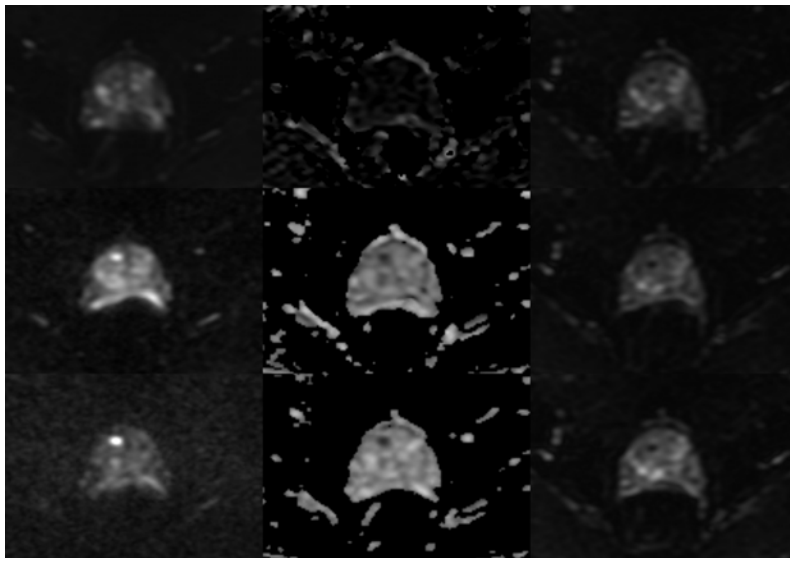
The transitional zone (TZ) demonstrates a 6 mm right mid identifiable abnormal T2W heterogeneous signal lesions with obscured margins or lenticular/non-circumscribed, homogeneous, at least moderately T2W hypointense lesions. No extraprostatic extension (EPE) is seen.

The peripheral zone (PZ) demonstrates the 6 mm right mid lesion and is identifiable with focal mildly/moderately hypointense lesion on ADC with isointense/mildly hyperintense signal on high b-value DWI or lesions focal markedly hypointense on ADC and markedly hyperintense on high b-value DWI. No extraprostatic extension (EPE) is seen.

The 6 mm right mid lesion has focal dynamic contrast enhancement including earlier than or contemporaneously enhancing with adjacent tissues on early wash-in phases.



Sag T2 (upper left), Ax T2 (upper right), Cor T2 (lower left) Ax Dynamic (lower right)



Axial DWI, ADC and IsoDWI (b=50) (upper row); (b=800) (middle row) and (b=1600) (lower row)

Lesion Number	Sector	Size (mm)	T2WI PI-RADS (1-5/X)	DWI PI-RADS (1-5/X)	DCE (+/-)	EPE (Y/N)	PI-RADS v2 FINAL (1-5)
1	RT MID TZ	6	3	5	+	N	5

The prostate anatomic capsule is intact. The seminal vesicles are intact. No peri-prostatic or iliac chain lymphadenopathy noted. Remaining soft tissues are unremarkable. Visualized bone marrow signal is unremarkable.

Diagnosis: A 6 mm right mid transitional zone lesion

PI-RADS v2 FINAL SCORE: 5 (Very high (clinically significant cancer is highly likely to be present). The patient agreed to have an MRI fused prostate biopsy. All tissue cores revealed benign prostatic hypertrophy. PSA 3 months following procedure declined to 5.32 ng/ml. Over the next 6 months, he developed progressively worse lower urinary tract symptoms. He was counseled regarding transurethral resection of the prostate to alleviate his symptoms. The procedure was performed and his resected prostate tissues again revealed benign prostate tissue with focal areas of chronic prostatitis.

Case 4

History: The 63-year-old male patient presented for a Prostate MRI to investigate elevated PSA of 6.53 ng/ml increased from 5.0 ng/ml the year before and 3.1 ng/ml three years prior. Patient's medical history includes a previous TRUS negative biopsy and a previous prostate MRI with PI-RADS v2 findings.

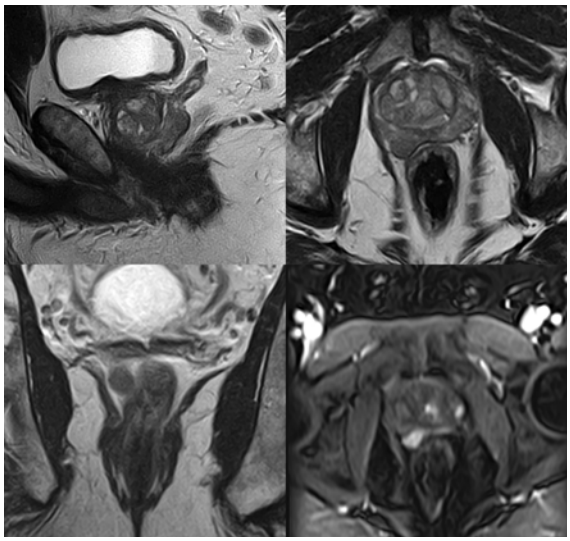
Latest Imaging Findings: The prostate gland measures 4.9 cm x 3.9 cm x 4.4 cm. This corresponds to a prostate volume of 43 grams. There is enlargement of the transitional zone with circumscribed hypointense/heterogeneous encapsulated nodule(s) consistent with BPH.

The transitional zone (TZ) demonstrates no identifiable abnormal T2W heterogeneous signal lesions with obscured margins or lenticular/non-circumscribed, homogeneous, at least moderately T2W hypointense lesions. No extraprostatic extension (EPE) is seen.

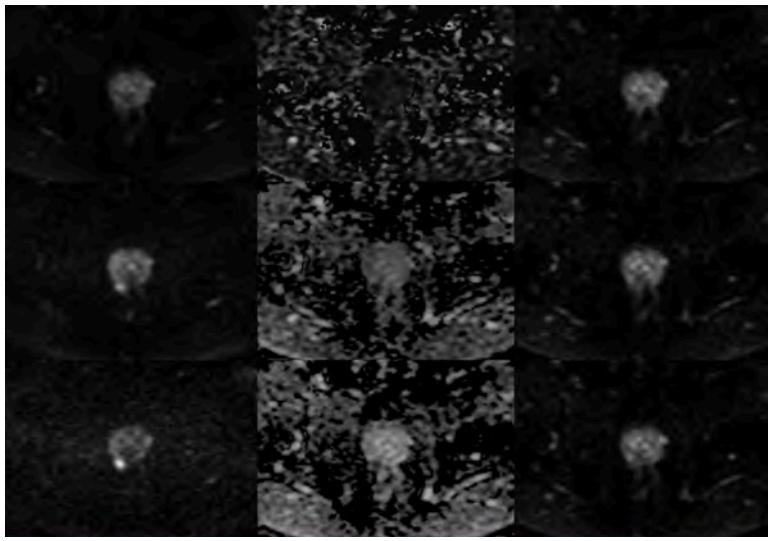
The peripheral zone (PZ) demonstrates one identifiable focal mildly/moderately hypointense lesions on ADC with isointense/mildly hyperintense signal on high b-value DWI or lesions focal markedly hypointense on ADC and markedly hyperintense on high b-value DWI. This is new since the prior exam. No extraprostatic extension (EPE) is seen.

The PZ lesion has focal dynamic contrast enhancement including earlier than or contemporaneously enhancing with adjacent tissues on early wash-in phases.

The prostate anatomic capsule is intact, however, the malignancy does deviate the capsule wall. The seminal vesicles are intact. No peri-prostatic or iliac chain lymphadenopathy noted. Remaining soft tissues are unremarkable. Visualized bone marrow signal is unremarkable.



Sag T2 (upper left), Ax T2 (upper right), Cor T2 (lower left) Ax Dynamic (lower right)



Axial DWI, ADC and IsoDWI (b=50) (upper row); (b=800) (middle row) and (b=1600) (lower row)

Lesion Number	Sector	Size (mm)	T2WI PI-RADS (1-5/X)	DWI PI-RADS (1-5/X)	DCE (+/-)	EPE (Y/N)	PI-RADS v2 FINAL (1-5)
1	RT MID PZ	16	3	5	+	N	5

***Protocol Parameters of images shown**

Sequence	FOV	Resolution	Scan Time	Other Parameters
Sag T2	19x19	0.3 x 0.3	6:36	
Cor T2	19x19	0.4 x 0.4	3:16	
Ax T2	20x20	0.4 x 0.4	3:05	
Ax Dynamic	25x18	0.7 x 0.7	0:07	7 sec/phase for 3 minutes
Ax DWI	24x32	1.3 x 1.3	3:17	IsoDWI, ADC

***All images shown were created on a Canon Vantage Titan 3T MRI system*

Diagnosis: Since the prior examination (2 years prior), there is now a 16 mm right mid-peripheral zone PI-RADS 5 lesion which deviates the capsule

PI-RADS v2 FINAL SCORE: 5 ((Very high (clinically significant cancer is highly likely to be present). The patient underwent an MR fused biopsy. Tissue from the Right mid lesion revealed Gleason 4+4=8 adenocarcinoma in 15% of the tissue removed. Additionally, Gleason 4+3 = 7 and 4+4=8 were identified in the right apex and right base respectively. He was counseled regarding all treatment options and elected to undergo Robotic Assisted Laparoscopic radical prostatectomy with pelvic lymphadenectomy after preoperative staging evaluation revealed no evidence of metastatic disease. Final pathology revealed T3aN0Mx Gleason 4+3=7 adenocarcinoma with positive surgical margins at the right posterior and left lateral margins. Initial PSA level was 0.02 ng/ml but due to T3 disease, he elected adjuvant radiation which he completed. Most recent PSA level is 0.06 ng/ml and the patient is clinically stable.

Discussion

Prostate cancer is a very common malignancy among men in the US. However, there are essentially two clinical challenges to the prostate cancer care spectrum: how to improve detection of clinically significant cancer (to reduce mortality) and how to increase confidence identifying benign diseases and dormant malignancies to reduce unnecessary interventions (as biopsies and treatments). In addition, an option for low-grade cancers is active surveillance. A non-invasive method to monitor tumor progress could eliminate the need for additional biopsies or surgery.

In order to address these clinical challenges, the prostate MRI protocol recommended by PI-RADS (Prostate Imaging-Reporting and Data Systems – version 2)[2] is basically built on three major pillars: T2-weighted imaging for anatomy analysis, diffusion-weighted imaging for characterization and perfusion-weighted imaging for detection. This multiparametric approach to the prostate MRI (mpMRI) allows visualization and diagnosis based on the highly-detailed images provided by the combination of these techniques.

In our facility, we performed prostate MRI exams on a Canon 3T wide bore magnet** equipped with lightweight phased-array coils and innovative noise reduction technology – the Pianissimo technology – in order to increase patient compliance to the test and reduce anxiety regarding the procedure. Additionally, in order to increase patient comfort, decrease costs and examination time, and avoid anatomy deformation and artifacts, we use a combination of phased-array coils positioned around patient's pelvis without the use of an endorectal coil. This approach had been corroborated by studies that concluded that the overall staging accuracy, sensitivity, and specificity were not significantly different between the endorectal coil and pelvic phased-array coil MRI[3]. Another paper by Baur et al[4], concludes that lesion identification and evaluation on T2WI and DWI performed on 3T didn't differ significantly with both coil setups, thus the use of an endorectal coil may be omitted in a prostate cancer detection setting.

Conclusion

There are many potential uses for MR Imaging in Prostate Cancer: diagnosis, staging, active surveillance, surgical planning, radiation planning, and biopsy planning are just some of them. Furthermore, because prostate MRI provides detailed anatomic and functional images of the prostate and surrounding structures, in our institution we have found it has increased our confidence in detection of clinically significant cancer, to identify benign diseases as well as dormant malignances and enabled us to reduce unnecessary interventions when the disease doesn't have a significant impact on patients' quality of life.

REFERENCES

1. *American Cancer Society. Cancer Facts & Figures 2018. Atlanta, Ga: American Cancer Society; 2018.*

2. *PI-RADS Prostate Imaging-Reporting and Data Systems. 2015 Version 2. American College of Radiology.*

3. *Kim BS, Kim TH, Kwon TG, Yoo ES. Comparison of pelvic phased-array versus endorectal coil magnetic resonance imaging at 3 Tesla for local staging of prostate cancer. Yonsei Med J 2012; 53(3):550-6.*

4. *T2- and diffusion-weighted magnetic resonance imaging at 3 T for the detection of prostate cancer with and without endorectal coil: An intraindividual comparison of image quality and diagnostic performance. Baur, Alexander D.J. et al. European Journal of Radiology, Volume 85, Issue 6, 1075 - 1084.*

Results described in this document are the experience of the author.
Results may vary due to clinical setting, patient presentation, and other factors.

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