Section: Radiology

Original Research Article

ASSESSMENT OF PROSTATE CANCER WITH MAGNETIC RESONANCE IMAGING

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Abstract

Background: To assess prostate cancer with Magnetic resonance imaging (MRI). **Materials and Methods:** Fifty- two patients of prostate cancer underwent MRI of the pelvis performed using a 3-T magnet equipped with a phased-array coil and an endorectal coil. The MRI protocol included the following sequences: T2-weighted (T2w) turbo spin-echo sequences in axial, sagittal, and coronal planes. Diffusion-weighted imaging (DWI) sequences: slice thickness, 3 mm; TR, 3,100 ms; TE, 102 ms; and exponential b values of 0, 500, 1,000, and 3,000 s/mm2. Dynamic contrast-enhanced (DCE) MRI was obtained using a gradient-echo T1-weighted sequence in axial planes. **Result:** Age group 20-40 years had 10, 40-60 years had 12 and 60-80 years had 30 patients. The difference was significant (P< 0.05). Gleason grading was indolent well-differentiated tumour seen in 28, intermediate risk in 14 and clinically aggressive in 10 cases. The difference was significant (P< 0.05). MRI sequences T2w showed sensitivity, specificity, PPV, NPV, accuracy and AUC of 68, 74, 90, 60, 77 and 0.71. T2w+ DCE showed 70, 80, 92, 65, 86 and 0.89. T2w+ DWI showed 74, 84, 96, 69, 90 and 0.84. DWI+DCE showed 84, 90, 97, 73, 92 and 0.91 and T2w+ DCE+ DWI showed 86, 95, 99, 79, 95 and 0.96 respectively. **Conclusion:** Magnetic resonance imaging (MRI) has high sensitivity, specificity, PPV, NPV, accuracy and AUC in detection of prostate cancer in men.

INTRODUCTION

Prostate cancer (PCa) is the second leading cause of cancer mortality in men in the United States and other developed countries.[1] Because PCa tumors usually grow slowly, many men live with this cancer (>2.9 million men in the United States); this situation represents a large burden of disease. Given the sizable number of affected individuals, imaging methods for improving diagnosis, assessing the response to therapy, and identifying early recurrence are of great interest.[2] Over thirty- five thousand (35000) new cases of prostate cancer are diagnosed per annum in the UK and there are over 10000 deaths annually. It is the most common cancer in males in the UK, and causes 13% of all cancer deaths in males.[3] The lifetime risk of being diagnosed with prostate cancer is one in nine. It has been estimated from post-mortem data that approximately half of all males in their fifties have prostate cancer, which increases to 80% by the age of 80 years, but only 1 in 26 men will die from their disease supporting the fact that males are more likely to die with prostate cancer than from it.[4]

Multiparametric MRI (mpMRI), which includes both anatomic (T2-weighted MRI) and functional (diffusion-weighted MRI and dynamic contrast–enhanced MRI) pulse sequences, has been an integral component of PCa management for the last decade.[5] More commonly used for mapping localized PCa, it has been beneficial in guiding biopsies, even in patients with persistently high serum prostate-specific antigen (PSA) levels and inconclusive workups, as well as for treatment follow-up in patients after definitive therapy. However, the staging of PCa has been more challenging.[6] We performed this study to assess prostate cancer with Magnetic resonance imaging (MRI).

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MATERIALS AND METHODS

After considering the utility of the study and obtaining approval from ethical review committee, we selected fifty- two patients of prostate cancer. Patients' consent was obtained before starting the study.

Data such as name, age, gender etc. was recorded. A thorough physical examination was carried out. MRI of the pelvis was performed using a 3-T magnet equipped with a phased-array coil and an endorectal coil. The MRI protocol included the following sequences: T2-weighted (T2w) turbo spin-echo sequences in axial, sagittal, and coronal planes. Diffusion-weighted imaging (DWI) sequences: slice thickness, 3 mm; TR, 3,100 ms; TE, 102 ms; and exponential b values of 0, 500, 1,000, and 3,000 s/mm2. Dynamic contrast-enhanced (DCE) MRI was obtained using a gradient-echo T1-weighted sequence in axial planes. The results were compiled and subjected for statistical analysis using Mann Whitney U test. P value less than 0.05 was set significant.

RESULTS

Age group 20-40 years had 10, 40-60 years had 12 and 60-80 years had 30 patients. The difference was significant (P< 0.05) [Table 1].

Table 1: Distribution of patients

Age group (years)	Number	P value
20-40	10	0.05
40-60	12	
60-80	30	

Table 2: Assessment of Gleason grading

Gleason grading	Number	P value
Indolent well-differentiated tumour	28	0.05
Intermediate risk	14	
Clinically aggressive	10	

Gleason grading was indolent well-differentiated tumour seen in 28, intermediate risk in 14 and clinically aggressive in 10 cases. The difference was significant (P< 0.05) [Table 2].

Table 3: mp-MRI results in detecting PCa

MRI sequences	Sensitivity	Specificity	PPV (%)	NPV (%)	Accuracy	AUC
T2w	68	74	90	60	77	0.71
T2w+ DCE	70	80	92	65	86	0.89
T2w+ DWI	74	84	96	69	90	0.84
DWI+DCE	84	90	97	73	92	0.91
T2w+ DCE+ DWI	86	95	99	79	95	0.96

MRI sequences T2w showed sensitivity, specificity, PPV, NPV, accuracy and AUC of 68, 74, 90, 60, 77 and 0.71. T2w+ DCE showed 70, 80, 92, 65, 86 and 0.89. T2w+ DWI showed 74, 84, 96, 69, 90 and 0.84. DWI+DCE showed 84, 90, 97, 73, 92 and 0.91 and T2w+ DCE+ DWI showed 86, 95, 99, 79, 95 and 0.96 respectively.

DISCUSSION

MRI is superior in diagnosing and characterizing localized soft-tissue disease and assisting in the evaluation of specific bone lesions, especially with T1-weighted and DW imaging.[7] PET is superior in providing biologic information about the cancer and is sensitive and highly specific for residual or recurrent disease.[8] Multiparametric magnetic resonance imaging (mp-MRI), combining the morphological assessment of T2-weighted imaging (T2WI) with diffusion-weighted imaging (DWI), dynamic contrast-enhanced (DCE) perfusion imaging and spectroscopic imaging (MRSI), has been extensively studied in recent years.[9] In particular, T2WI and DWI have shown considerable promise in the detection, localization, risk stratification and staging of prostate cancer.[10,11] We performed this study to assess prostate cancer with Magnetic resonance imaging (MRI).

Our results showed that age group 20-40 years had 10, 40-60 years had 12 and 60-80 years had 30 patients. The recommended technique of MRI in prostate cancer is mp-MRI, which includes high-resolution T2WI and at least two functional MRI techniques.[12] T1-wegithed imaging is of limited use in assessing prostate morphology or in identifying tumor within the gland. Its main use is in detecting post-biopsy hemorrhage. Bowel motion artefacts should be reduced by administering anti-peristaltic agents.[13] Prostate imaging at 3T benefits from higher signal to noise ratio. Use of endorectal coil (ERC) is not an absolute requirement for cancer detection protocol, but is preferable at 1.5T. ERC use is recommended for staging purposes, although patient acceptability and increased costs remain its drawbacks. Air can be used to inflate the ERC balloon, but may cause distortion of DWI. Distention with liquids (perflurocarbon or barium suspension) will prevent susceptibility artefacts.

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Usually, about 60 cc of air or fluid is required to distend the balloon.[14,15]

Our results showed that Gleason grading was indolent well-differentiated tumour seen in 28, intermediate risk in 14 and clinically aggressive in 10 cases. Panebionco et al,[16] assessed whether the proportion of men with clinically significant prostate cancer (PCa) is higher among men randomized to multiparametric magnetic resonance imaging (mp-MRI)/biopsy vs. those randomized to transrectal ultrasound (TRUS)-guided biopsy. In total, 1,140 patients with symptoms highly suggestive of PCa were enrolled and divided in 2 groups of 570 patients to follow 2 different diagnostic algorithms. Group A underwent a TRUS-guided random biopsy. Group B underwent an mp-MRI and a TRUS guided targeted þ random biopsy. The accuracy of mp-MRI in the diagnosis of PCa was calculated using prostatectomy as the standard of reference. Results: In group A, PCa was detected in 215 patients. The remaining 355 patients underwent an mp-MRI: the findings were positive in 208 and unremarkable in 147 patients. After the second random þ targeted biopsy, PCa was detected in 186 of the 208 patients. In group B, 440 patients had positive findings on mp-MRI, and PCa was detected in 417 at first biopsy; 130 group B patients had unremarkable findings on both mp-MRI and biopsy. In the 130 group B patients with unremarkable findings on mp-MRI and biopsy, a PCa Gleason score of 6 or precancerous lesions were detected after saturation biopsy. mp-MRI showed an accuracy of 97% for the diagnosis of PCa. The proportion of men with clinically significant PCa is higher among those randomized to mp-MRI/biopsy vs. those randomized to TRUS-guided biopsy; moreover, mp-MRI is a very reliable tool to identify patients to schedule in active surveillance.

Our results showed that MRI sequences T2w showed sensitivity, specificity, PPV, NPV, accuracy and AUC of 68, 74, 90, 60, 77 and 0.71. T2w+ DCE showed 70, 80, 92, 65, 86 and 0.89. T2w+ DWI showed 74, 84, 96, 69, 90 and 0.84. DWI+DCE showed 84, 90, 97, 73, 92 and 0.91 and T2w+ DCE+ DWI showed 86, 95, 99, 79, 95 and 0.96 respectively. The prostate gland can be divided into the peripheral and central glands. The peripheral gland comprises the peripheral zone, which comprises the most glandular tissue, and 70% of prostate cancers arise here. On T2-weighted imaging, because the normal peripheral zone has high signal intensity and tumor has low signal intensity, a tumor is usually easily identified.[17] However, signal intensity changes within the prostate should be interpreted with caution because other pathologic processes, including infection, postbiopsy hemorrhage, fibrosis, inflammation, chronic prostatitis, BPH, effects of hormone or radiation treatment, scars, calcifications, smooth muscle hyperplasia, and fibromuscular hyperplasia, can mimic cancer because these processes all appear as low signal intensity within the peripheral zone on T2-weighted imaging. It is recommended to wait 8–12 weeks after biopsy to perform MRI to avoid misinterpretation, although methemoglobin within hemorrhage is seen as high signal intensity on T1-weighted imaging, which helps differentiate it from tumor.[18]

Park et al,[19] in their study men with an abnormal digital rectal examination or high PSA level were enrolled. Participants were randomly allocated into two groups; the MRI group underwent 3-T MRI and then a transrectal ultrasound-guided biopsy with knowledge of the cancer location. The non-MRI group did not undergo MRI before transrectal ultrasound-guided biopsy. The cancer detection rate and positive core rate were obtained to compare the MRI and non-MRI groups. The MRI and non-MRI groups contained 44 and 41 patients, respectively. There was no significant difference between the two groups with respect to age, PSA, and prostate volume. The MRI group (13/44, 29.5%) had a significantly higher cancer detection rate than the non-MRI group (4/41, 9.8%) ($p = 0.03$). The MRI group (52/527, 9.9%) had a significantly higher positive core rate than the non-MRI group (11/432, 2.5%) ($p = 0.00$). Regarding cancer detection rate and positive core rate, odds ratios were 3.9 (95% CI, 1.1-13.1) and 4.2 (95% CI, 2.2-8.1), respectively. In patients with PSA level and no previous biopsy, 3-T MRI that is performed before transrectal ultrasound-guided biopsy may contribute to the detection of prostate cancer.

CONCLUSION

Magnetic resonance imaging (MRI) has high sensitivity, specificity, PPV, NPV, accuracy and AUC in detection of prostate cancer in men.

REFERENCES

1. Baco E, Rud E, Vlatkovic L, et al. Predictive value of magnetic resonance imaging determined tumor contact length for extracapsular extension of prostate cancer. J Urol. 2015;193:466–472.
2. Roethke M, Kaufmann S, Kniess M, et al. Seminal vesicle invasion: accuracy and analysis of infiltration patterns with high-spatial resolution T2-weighted sequences on endorectal magnetic resonance imaging. Urol Int. 2014;92:294– 299.
3. Raskolnikov D, George AK, Rais- Bahrami S, et al. Multiparametric magnetic resonance imaging and image-guided biopsy to detect seminal vesicle invasion by prostate cancer. J Endourol. 2014;28:1283–1289.
4. Abd-Alazeez M, Ramachandran N, Dikaios N, et al. Multiparametric MRI for detection of radiorecurrent prostate cancer: added value of apparent diffusion coefficient maps and dynamic contrast-enhanced images. Prostate Cancer Prostatic Dis. 2015;18:128–136.
5. Muller BG, Kaushal A, Sankineni S, et al. Multiparametric magnetic resonance imaging-transrectal ultrasound fusion-assisted biopsy for the diagnosis of local recurrence after radical prostatectomy. Urol Oncol. 2015;33:425– 425.
6. Arrayeh E, Westphalen AC, Kurhanewicz J, et al. Does local recurrence of prostate cancer after radiation therapy occur at the site of primary tumor? Results of a longitudinal MRI and MRSI study. Int J Radiat Oncol Biol Phys. 2012;82:787–793.

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7. Freitag MT, Radtke JP, Hadaschik BA, et al. Comparison of hybrid 68Ga-PSMA PET/MRI and 68Ga-PSMA PET/CT in the evaluation of lymph node and bone metastases of prostate cancer. Eur J Nucl Med Mol Imaging. 2016;43:70–83.
8. Jambor I, Kuisma A, Ramadan S, et al. Prospective evaluation of planar bone scintigraphy, SPECT, SPECT/CT, 18F-NaF PET/CT and whole body 1.5T MRI, including DWI, for the detection of bone metastases in high- risk breast and prostate cancer patients: SKELETA clinical trial. Acta Oncol. 2016;55:59–67.
9. Jadvar H. Positron emission tomography in prostate cancer: summary of systematic reviews and meta-analysis. Tomography. 2015;1:18–22.
10. Mena E, Turkbey B, Mani H, et al. 11C-acetate PET/CT in localized prostate cancer: A study with MRI and histopathologic correlation. J Nucl Med. 2012; 53:538–545.
11. Treglia G, Ceriani L, Sadeghi R, Giovacchini G, Giovanella L. Relationship between prostate-specific antigen kinetics and detection rate of radiolabelled choline PET/CT in restaging prostate cancer patients: a meta-analysis. Clin Chem Lab Med. 2014;52:725–733.
12. Barentsz JO, Richenberg J, Clements R, Choyke P, Verma S, Villeirs G, et al. ESUR prostate MR guidelines 2012. Eur Radiol 2012;22:746–57.
13. Panebianco V, Barchetti F, Sciarra A, Ciardi A, Indino EL, Papalia R, Gallucci M, Tombolini V, Gentile V, Catalano C. Multiparametric magnetic resonance imaging vs. standard care in men being evaluated for prostate cancer: A randomized study. In Urologic oncology: seminars and original investigations 2015;33 (1):17-1.
14. Heidenreich A, Bastian PJ, Bellmunt J, Bolla M, Joniau S, van der Kwast T, et al. EAU guidelines on prostate cancer. Part II: treatment of advanced, relapsing, and castration-resistant prostate cancer. Eur Urol 2014;65:467–79.
15. Scattoni V, Zlotta A, Montironi R, Schulman C, Rigatti P, Montorsi F. Extended and saturation prostatic biopsy in the diagnosis and characterisation of prostate cancer: a critical analysis of the literature. Eur Urol 2007;52:1309–22.
16. Panebianco V, Barchetti F, Sciarra A, Musio D, Forte V, Gentile V, et al. Prostate cancer recurrence after radical prostatectomy: the role of 3-T diffusion imaging in multi-parametric magnetic resonance imaging. Eur Radiol 2013;23:1745–52.
17. Sciarra A, Barentsz J, Bjartell A, Eastham J, Hricak H, Panebianco V, et al. Advances in magnetic resonance imaging: how they are changing the management of prostate cancer. Eur Urol 2011;59:962–77.
18. Dickinson L, Ahmed HU, Allen C, Barentsz JO, Carey B, Futterer JJ, et al. Magnetic resonance imaging for the detection, localisation, and characterisation of prostate cancer: recommendations from a European consensus meeting. Eur Urol 2011;59:477–94.
19. Park BK, Park JW, Park SY, Kim CK, Lee HM, Jeon SS, Seo SI, Jeong BC, Choi HY. Prospective evaluation of 3-T MRI performed before initial transrectal ultrasound–guided prostate biopsy in patients with high prostate-specific antigen and no previous biopsy. American Journal of Roentgenology. 2011 Nov;197(5):876-81.

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