REVIEW PAPER

Michał Osuchowski [1(ABDFG)], David Aebisher [2(ABDFG)], Sabina Galiniak [3(ABDFG)],
Dorota Bartusik-Aebisher [3(ABDFG)], Ewa Kaznowska [1(ABDFG)]

Multiparametric MRI and other imaging methods suitable to stage prostate carcinoma

[1] Clinical Department of Pathomorphology, Clinical Hospital No. 1, Faculty of Medicine,
University of Rzeszów, Rzeszów, Poland
[2] Department of Photomedicine and Physical Chemistry, Faculty of Medicine, University of Rzeszów,
Rzeszów, Poland
[3] Department of Biochemistry and General Chemistry, Faculty of Medicine, University of Rzeszów,
Rzeszów, Poland

ABSTRACT

Introduction. The role of multiparametric magnetic resonance imaging (mpMRI) in staging prostate carcinoma has been increasing over the last years. It's high sensitivity is indispensable when diagnosing this disease. It is a very accurate imaging method that helps the physician choose the best treatment method for his patient.

Aim. Assessment of mpMRI which uses both anatomic and functional imaging techniques as a method to diagnose prostatic lesions. Advantages and disadvantages of staging prostate carcinoma with the use of biparametric MRI (bpMRI).

Methods. The literature search was performed.

Results. MpMRI can be used in pre-operative staging of prostate cancer. The technique is accurate in diagnosing and assessment of prostate carcinoma with Gleason Score (GS) of 7 and above. It is also recommended when planning a second biopsy of the prostatic gland.

Keywords: Prostate cancer, multiparametric MRI (mpMRI), biparametric MRI (bpMRI), staging

Prostate carcinoma

Prostate carcinoma is the second most frequent malignant tumor diagnosed in the male population worldwide.[1-3] Over 85% of cases are seen in patients over 65 years of age.[4] Pathologists in the United States diagnose prostate carcinoma in over 80% of patients in their 70's upon post mortem tissue examiantion.[5] Differentiating lethal from nonlethal disease is the number one issue due to controversies concerning the correct treatment.[6] Correct assessment of clinical stage and a pathologic stage are crucial.[7] No imaging can accurately confirm or exclude presence of a prostate carcinoma. Diagnosis relies on microscopic

examination of prostatic tissue.[6] Diagnostic imaging can be used however for staging of local disease. While computed tomography (CT) isn't capable of reliable detection of prostate cancer, MR shows a lot of promise.[8,9] Guidelines for staging prostate carcinoma include not using CT or transrectal ultrasound in any risk group, not using additional imaging in low-risk group for staging purposes and using mpMRI in intermediate-risk and high-risk groups.[7] There are several ways to perform an MRI while attempting to stage prostatic carcinoma. Multiparametric MRI uses a combination of T_2 – weighted imaging, diffusion imaging, perfusion and spectroscopic imaging while biparametric focuses on morphologic T_2 – weighted imaging and diffusion-weighted imaging.[10-12] Associating T_2 – weighted imaging with at least one functional imaging technique (DWI, DCE, ^1H spectroscopy) has good sensitivity for the detection and localization of GS ≥ 7 cancers in expert centers. For a tumor volume less than 0.5 mL the sensitivity is 63% for GS = 7 and 80% for GS above 7. When evaluating larger lesions the sensitivity is higher – for tumor volume 0.5 – 2 mL 82-88% for GS = 7 and 93% for GS above 7 and for tumor volume over 2 mL 97% for GS = 7 and 100% for GS above 7.[13] A scoring system has been introduced to help reproduce good results in less-experienced centers. The first version of a system called PI-RADS has not proved an improved interobserver variability as compared with subjective scoring.[14] Currently, a second version of PI-RADS is being used and some authors suggest there is still room for improvement by, for example, adding ADC values to the equation.[15,16] Lots of studies performed in a single center suggest that multiparametric magnetic resonance imaging can reliably detect aggressive tumors with a negative predictive value (NPV) ranging from 63% to 98% and positive predictive value ranging from 34% to 68% .[17] Others show that even with the use of the PIRADS v2 scoring system, mpMRI inter-reader reproducibility is showing moderate specificity.[18-20] This fact limits its broad use outside expert centers. All this may lead to substantial patient mismanagement. This method of imaging is also not accurate enough to consistently grade tumor aggressiveness when planning focal therapy.[21,22] The upside is shown by the PROMIS study. It proved that mpMRI, used as a triage test before first prostate biopsy, could reduce unnecessary biopsies by 27%. It can also reduce over-diagnosis of clinically insignificant prostate cancer and improve detection of clinically significant cancer when compared with the standard pathway of TRUS-biopsy for all patients.[23,24] Pre-operative 3TmpMRI may even serve as a prognostic marker of treatment outcomes independently of biopsy GS or histological type of the carcinoma.[25] The most recent studies concentrate on reducing cost, time, and contrast exposure by eliminating the DCE phase of mpMRI. Scherrer et al. suggest that mpMRI can be replaced by biparametric MRI

(bpMRI) without forfeiting valuable diagnostic information. Biparametric MRI and multiparametric MRI have similar cancer detection rates, particularly for clinically significant cases of prostate carcinoma.[26-28] When staging prostate carcinoma hybrid imaging devices such as single-photon emission CT/CT gamma cameras (SPECT) or positron emission tomography/CT cameras (PET) are often a necessity. These methods are primarily used to diagnose metastases.[29-31] With SPECT imaging bone metastases can be detected with very high sensitivity and specificity (over 79% and 82% respectively).[32] PET imaging using ^{11}C-choline or ^{18}F-choline as contrast agents can be used to diagnose lymph node and bone metastases. For the latter sensitivity is at 100% and specificity is around 86%.[33,34] Due to relatively low glucose absorption by prostate carcinoma the use of FDG-PET imaging method is very limited.[35-40]

Conclusion

In conclusion, an MRI can accurately stage prostate carcinoma. This type of imaging has high sensitivity and moderate specificity when diagnosing the disease[36-38] and can be very helpful prior to a second biopsy or when planning the correct curative approach.[39,40]

Acknowledgments

References

1. Ferlay J, Soerjomataram I, Dikshit R, Eser S. Cancer incidence and mortality worldwide: sources, methods and major patterns in GLOBOCAN 2012. *Int J Cancer*. 2015;136 (5).

2. Torre LA, Bray F, Siegel R, et al. Global cancer statistics, 2012. *CA Cancer J Clin*. 2015;65(2): 87-108.

3. Torre LA, Siegel RL, Ward EM, Jemal A. Global Cancer Incidence and Mortality Rates and Trends-An Update. *Cancer Epidemiol Biomarkers* Prev. 2016;25(1):16-27.

4. Patel AR, Klein EA. Risk factors for prostate cancer. *Nat Clin Pract Urol*. 2009;6(2):87-95.

5. Delongchamps NB, Singh A, Haas GP. The role of prevalence in the diagnosis of prostate cancer. *Cancer Control*. 2006;13(3):158–168.

6. Kelloff GJ, Choyke P, Coffey DS. Prostate Cancer Imaging Working Group. Challenges in clinical prostate cancer: role of imaging. *AJR Am J Roentgenol*. 2009;192(6):1455-1470.

7. Mottet N, Bellmunt J, Briers E, et al. EAU-ESTRO-ESUR-SIOG Guidelines on Prostate Cancer. *European Urology*. 2017;71(4):618-629.

8. Turkbey B, Albert PS, Kurdziel K, Choyke PL. Imaging localized prostate cancer: current approaches and new developments. *AJR Am J Roentgenol*. 2009;192(6):1471-1480.

9. Hricak H, Choyke PL, Eberhardt SC, Leibel SA, Scardino PT. Imaging prostate cancer: a multidisciplinary perspective. *Radiology*. 2007;243(1):28-53.

10. Sangeet Ghai, Masoom A. Haider. Multiparametric-MRI in diagnosis of prostate cancer. *Indian J Urol*. 2015;31(3):194–201.

11. Berman RM, Brown AM, Chang SD, et al. DCE MRI of prostate cancer. *Abdom Radiol (NY)*. 2016;41(5):844-853.

12. Scialpi M, D'Andrea A, Martorana E, et al. Biparametric MRI of the prostate. *Turk J Urol*. 2017;43(4):401–409.

13. Bratan F, Niaf E, Melodelima C. Influence of imaging and histological factors on prostate cancer detection and localisation on multiparametric MRI: a prospective study. *Eur Radiol*, 2013;23(7):2019-2029.

14. Vache T, Bratan F, Mège-Lechvallier F, eta al. Characterization of prostate lesions as benign or malignant at multiparametric MR imaging: comparison of three scoring systems in patients treated with radical prostatectomy. *Radiology*. 2014;272:446-455.

15. Barentsz JO, Weinreb JC, Verma S, et al. Synopsis of the PI-RADS v2 guidelines for multiparametric prostate magnetic resonance imaging and recommendations for use. *Eur Urol*. 2016;69:41-49.

16. Jordan EJ, Fiske C, Zagoria R, Westphalen AC. PI-RADS v2 and ADC values: is there room for improvement? *Abdom Radiol (NY)*. 2018;43(11):3109-3116.

17. Futterer JJ, Briganti A, De Visschere P, et al. Can clinically significant prostate cancer be detected with multiparametric magnetic resonance imaging? A systematic review of the literature *Eur Urol*. 2015;68:1045-1053.

18. Zhang L, Tang M, Chen S, Lei X, Zhang X, Huan Y. A meta-analysis of use of Prostate Imaging Reporting and Data System Version 2 (PI-RADS V2) with multiparametric MR imaging for the detection of prostate cancer. *Eur Radiol*. 2017;27(12):5204-5214.

19. Smith CP, Türkbey B. PI-RADS v2: Current standing and future outlook. *Turk J Urol*. 2018;44(3):189–194.

20. Müller S, Lilleaasen G, Sand TE, et al. Poor reproducibility of PIRADS score in two multiparametric MRIs before biopsy in men with elevated PSA. *World J Urol*. 2018;36(5):687-691.

21. Muller BG, Fütterer JJ, Gupta RT, et al. The role of magnetic resonance imaging (MRI) in focal therapy for prostate cancer: recommendations from a consensus panel. *BJU Int*. 2014;113(2):218-227.

22. Wysocki JS, Lepor H. Multi-parametric MRI imaging of the prostate-implications for focal therapy. *Transl Androl Urol*. 2017;6(3):453-463.

23. Ahmed HU, El-Shater Bosaily A, Brown LC, et al. Diagnostic accuracy of multi-parametric MRI and TRUS biopsy in prostate cancer (PROMIS): a paired validating confirmatory study. *Lancet*. 2017.

24. Killock D. Prostate cancer: Improving diagnosis - can MP-MRI fulfil its PROMIS? *Nat Rev Clin Oncol*. 2017;14(3):137.

25. Faiena I, Salmasi A, Mendhiratta N, et al. PI-RADSv2 Category on 3 Tesla Multiparametric Prostate MRI Predicts Oncologic Outcomes in Gleason 3+4 Prostate Cancer on Biopsy. *J Urol*. 2018;21.

26. Sherrer RL, Glaser ZA, Gordetsky JB, Nix JW, Porter KK, Rais-Bahrami S. Comparison of biparametric MRI to full multiparametric MRI for detection of clinically significant prostate cancer. *Prostate Cancer Prostatic Dis*. 2018;9.

27. Kuhl CK, Bruhn R, Krämer N, Nebelung S, Heidenreich A, Schrading S. Abbreviated Biparametric Prostate MR Imaging in Men with Elevated Prostate-specific Antigen. *Radiology*. 2017;285(2):493-505.

28. Di Campli E, Delli Pizzi A, Seccia B, et al. Diagnostic accuracy of biparametric vs multiparametric MRI in clinically significant prostate cancer: Comparison between readers with different experience. *J Radiol*. 2018;101:17-23.

29. Outwater EK, Montilla-Soler JL. Imaging of prostate carcinoma. *Cancer Control*. 2013;20(3):161-176.

30. Schuster DM, Nanni C, Fanti S. Evaluation of Prostate Cancer with Radiolabeled Amino Acid Analogs. *J Nucl Med*. 2016;57(3):61-66.

31. Langsteger W, Rezaee A, Pirich C, Beheshti M. 18F-NaF-PET/CT and 99mTc-MDP Bone Scintigraphy in the Detection of Bone Metastases in Prostate Cancer. *Semin Nucl Med*. 2016;46(6):491-501.

32. Even-Sapir E, Metser U, Mishani E, Lievshitz G, Lerman H, Leibovitch I. The detection of bone metastases in patients with high-risk prostate cancer: 99mTc-MDP Planar bone scintigraphy, single- and multi-field-of-view SPECT, 18F-fluoride PET, and 18F-fluoride PET/CT. *J Nucl Med*. 2006;47(2):287-97.

33. Wallitt KL, Khan SR, Dubash S, Tam HH, Khan S, Barwick TD. Clinical PET Imaging in Prostate Cancer. *Radiographics*. 2017;37(5):1512-1536.

34. Parent EE, Schuster DM. Update on 18F-Fluciclovine PET for Prostate Cancer Imaging. *J Nucl Med*. 2018;59(5):733-739.

35. Schuster DM, Nanni C, Fanti S. PET Tracers Beyond FDG in Prostate Cancer. *Semin Nucl Med*. 2016;46(6):507-521.

36. Yu J, Fulcher AS, Turner MA, Cockrell CH, Cote EP, Wallace TJ. Prostate cancer and its mimics at multiparametric prostate MRI. *Br J Radiol*. 2014;87(1037):20130659.

37. Zhu Y, Wang L, Liu M, Qian C, Yousuf A, Oto A, Shen D. MRI-based prostate cancer detection with high-level representation and hierarchical classification. *Med Phys*. 2017;44(3):1028-1039.

38. Thomas S, Oto A. Multiparametric MR imaging of the Prostate: Pitfalls in Interpretation. *Radiol Clin North Am*. 2018;56(2):277-287.

39. Bockholt N, Marks LS.Targeted prostate biopsy using magnetic resonance imaging-ultrasound fusion. *Asian J Androl*. 2015;17(6):870-3.

40. Lista F, Castillo E, Gimbernat H, Rodríguez-Barbero JM, Panizo J, Angulo JC. Multiparametric magnetic resonance imaging predicts the presence of prostate cancer in patients with negative prostate biopsy. *Actas Urol Esp*. 2015;39(2):85-91.