© Wydawnictwo UR 2019
ISSN 2544-1361 (online); ISSN 2544-2406
doi: 10.15584/ejcem.2019.1.11

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2019; 17 (1): 67–70

REVIEW PAPER

Michał Osuchowski [1(ADFG)], David Aebisher [2(FG)], Joanna Gustalik [1(AG)], Dorota Bartusik-Aebisher [3(FG)], Ewa Kaznowska [1(FG)]

The advancement of imaging in diagnosis of prostate cancer

[1] Department of Pathomorphology, 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. Multiple imaging methods have been used to stage prostate carcinoma. Some of them are easily accessible, others very accurate. The advancements over many years have been taken under consideration and now every imaging method has a specific role in the diagnosis of this malignancy.

Aim. There are over 1,100,000 cases of prostate carcinoma diagnosed every year around the world. Imaging examinations have to be introduced to accurately stage, and therefore properly treat this disease. This review concentrates on advantages and disadvantages of different imaging methods.

Material and methods. The literature search was performed.

Results. Imaging methods serve specific goals. TRUS is recommended for acquiring biopsy specimen due to high accessibility and low cost of the examination.

Conclusion. The best tool for staging prostate carcinoma and finding suspicious lesions when attempting second biopsy is mpMRI or bpMRI.

Keywords. MRI, PET, prostate carcinoma

Imaging

Prostate carcinoma is the second most frequent malignant tumor diagnosed in the male population worldwide.[1-3] North America and Europe are the regions with the highest number of newly diagnosed cases.[4] Studies prove that this neoplasm will affect 1 in every 6 men during their lifetime.[5,6] Pathologists in the United States diagnose prostate carcinoma in over 80% of patients in their 70's upon post mortem tissue examiantion.[7,8] Therefore, diagnosing a clinically relevant disease that requires treatment is a priority.[9] Physical examination and Prostate Specific Antigen (PSA) serum levels are usually the first tests when diagnosing prostate carcinoma.[10] PSA serum levels can be increased not only by

Corresponding author: David Aebisher, email: daebisher@ur.edu.pl

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 15.11.2018 | Accepted: 15.01.2019
Publication date: March 2019

Osuchowski M, Aebisher D, Gustalik J, Bartusik-Aebisher D, Kaznowska E. *The advancement of imaging in diagnosis of prostate cancer.* Eur J Clin Exp Med. 2019;17(1):67–70. doi: 10.15584/ejcem.2019.1.11

cancer, but also by other diseases or factors, for example an inflammation of the prostatic gland.[11] Other tools have to be introduced to properly identify and stage prostate carcinoma.[10,12]

The first imaging method used to evaluate the prostatic gland lesions was the transrectal ultrasound (TRUS). It provided good-quality images of the organ because a high-frequency probe was placed in the rectum close to the prostate.[13-15] Initially TRUS of prostate was performed to evaluate for prostatic disease including prostate cancer, benign prostatic hyperplasia (BPH), prostatitis, prostatic abscess, and prostatic calculi.[16-19] Currently, it is mainly used for TRUS guided core biopsies. [10,20,21] Most cases of prostate carcinoma are hypoechoic or hyperechoic on ultrasound imaging but even up to 40% are isoechoic. This fact significantly limits the role of TRUS in detection of this malignancy.[23,24] Furthermore hypoechoic areas within the peripheral zone can also be seen in benign processes.[25] A significant part of TRUS called volume assessment of the prostate is useful in planning treatment with brachytherapy or cryotherapy.[16] Most recent advances in ultrasound imaging include micro-ultrasound systems that introduce 29 MHz probe to assess the risk of prostatic carcinoma and enable real-time targeted biopsies. New methods allow for decreasing clinically-insignificant cancer diagnoses and detecting high risk disease early.[26-28] Computed tomography scans are used to identify metastases but not for staging the disease.[9,10] MRI is the most accurate and reliable non-invasive method when diagnosing prostate carcinoma.[29] It has been suggested that magnetic resonance spectroscopic imaging (MRS) is even capable of determining the grade of prostate carcinoma.[30] The currently used 3-Tesla MRI offers high resolution view that is capable of identifying small foci of cancer that are not visible on TRUS.[31-34] The combination of basic T_1-weighted and T_2-weighted images and more advanced dynamic contrast-enhanced (DCE) or diffusion-weighted (DWI) imaging is called multiparametric MRI (mpMRI). This method has the highest negative predictive value of all imaging techniques.[12,33] The mpMRI is currently being used mostly to diagnose patients with high risk of prostate carcinoma and a negative result in first biopsy. It helps to identify the most suspicious areas in order to guide the second biopsy. This helps in obtaining the most representative tissue sample.[35,36] In spite of all of the advantages of mpMRI, it is not the primary imaging method for biopsy guidance.[10] This is the case for several reasons. The mpMRI's availability is limited, it's expensive and has low inter-reader reproducibility.[37,38] Some authors suggest that these problems could be at least partially solved by biparametric MRI (bpMRI). Reducing cost, time, and contrast exposure is achieved by eliminating the DCE phase of the imaging without forfeiting valuable diagnostic information. Both bpMRI and mpMRI offer similar cancer detection rates for clinically significant prostate carcinoma.[39,40]

When evaluating the stage of prostate carcinoma hybrid imaging devices in the form of single-photon emission CT/CT gamma cameras (SPECT) or positron emission tomography/CT cameras (PET) are very useful. These methods are designed to diagnose metastases.[41] With SPECT imaging bone metastases can be detected with very high sensitivity and specificity (over 79% and 82% respectively).[42] 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%.[18] Due to relatively low glucose absorption by prostate carcinoma, the use of FDG-PET imaging method is very limited. [22]

Conclusion

The advancements in imaging methods have allowed for accurate staging of prostate carcinoma when evaluating the clinically significant disease. This leads to more effective treatment and surveillance of patients with this malignancy. The mortality of patients with prostate carcinoma, second most frequent malignant tumor in men, is only at around 10% and diagnostic imaging is a big part of that success.[43]

Acknowledgments

Dorota Bartusik-Aebisher acknowledges support from the National Center of Science NCN (New drug delivery systems-MRI study, Grant OPUS-13 number 2017/25/B/ST4/02481).

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, F. Bray, R. L. Siegel, J. Ferlay. 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. Breslow N, Chan CW, Dhom G , et al. Latent carcinoma of prostate at autopsy in seven areas. *Int J Cancer*. 1977;20(5):680-8.
5. De Angelis R, Sant M, Coleman MP, et al. Cancer survival in Europe 1999-2007 by country and age: results of EUROCARE--5-a population-based study. *Lancet Oncol*. 2014;15(1):23-34.
6. Verdecchia A, Santaquilani M, Sant M. Survival for cancer patients in Europe. *Ann Ist Super Sanita*. 2009;45(3):315-24.
7. Delongchamps NB, Singh A, Haas GP. The role of prevalence in the diagnosis of prostate cancer. *Cancer Control. 2006*;13(3):158–168.

8. Bell KJ, Del Mar C, Wright G, Dickinson J, Glasziou P. Prevalence of incidental prostate cancer: A systematic review of autopsy studies. *Int J Cancer*. 2015;137(7):1749-57.
9. 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):1455-70.
10. Mottet N, Bellmunt J, Briers E, et al. EAU-ESTRO-ESUR-SIOG Guidelines on Prostate Cancer. *European Urology*. 2017;71(4):618-629.
11. Louie KS, Seigneurin A, Cathcart P, Sasieni P. Do prostate cancer risk models improve the predictive accuracy of PSA screening? A meta-analysis. *Ann Oncol*. 2015;26(5):848-64.
12. Pessoa RR, Viana PC, Mattedi RL, et al. Value of 3-Tesla multiparametric magnetic resonance imaging and targeted biopsy for improved risk stratification in patients considered for active surveillance. *BJU Int*. 2017;119(4):535-542.
13. Lee HY, Lee HJ, Byun SS, Lee SE, Hong SK, Kim SH. Classification of focal prostatic lesions on transrectal ultrasound (TRUS) and the accuracy of TRUS to diagnose prostate cancer. *Korean J Radiol*. 2009;10(3):244-51.
14. Tarcan T, Ozveri H, Biren T, Türkeri L, Akdas A. Evaluation of prostate specific antigen density and transrectal ultrasonography-guided biopsies in 100 consecutive patients with a negative digital rectal examination and intermediate serum prostate specific antigen levels. *Int J Urol*. 1997;4(4):362-7.
15. Terris MK, Hammerer PG, Nickas ME. Comparison of ultrasound imaging in patients undergoing transperineal and transrectal prostate ultrasound. *Urology*. 1998;52(6):1070-2.
16. O' Donoghue PM, McSweeney SE, Jhaveri K. Genitourinary imaging: current and emerging applications. *J Postgrad Med*. 2010;56(2):131-9.
17. Tzai TS, Lin JS, Yeh YC, Chow NH. The role of transrectal ultrasonography on the palpable and impalpable abnormal prostate. *Eur Urol*. 1995;27(2):142-5.
18. Wallitt KL, Khan SR, Dubash S, Tam HH, Khan S, Barwick TD. Clinical PET Imaging in Prostate Cancer. *Radiographics*. 2017;37(5):1512-1536.
19. Gomella LG, Labrie F, Gamito EJ, Brawer MK. Prostate cancer: risk assessment and diagnostic approaches. *Rev Urol*. 2001;3(2):31-8.
20. Danziger M, Shevchuk M, Antonescu C, Matthews GJ, Fracchia JA. Predictive accuracy of transrectal ultrasound-guided prostate biopsy: correlations to matched prostatectomy specimens. *Urology*. 1997;49(6):863-7.
21. Pinto F, Totaro A, Calarco A, et al. Imaging in prostate cancer diagnosis: present role and future perspectives. *Urol Int. 2011*;86(4):373-82.
22. Schuster DM, Nanni C, Fanti S. PET Tracers Beyond FDG in Prostate Cancer. *Semin Nucl Med*. 2016;46(6):507-521.
23. Engelbrecht MR, Barentsz JO, Jager GJ, et al. Prostate cancer staging using imaging. *BJU Int*. 2000;86(1):123-34.
24. Shinohara K, Wheeler TM, Scardino PT. The appearance of prostate cancer on transrectal ultrasonography: correlation of imaging and pathological examinations. *J Urol*. 1989;142(1):76-82.
25. Tyloch JF, Wieczorek AP. The standards of an ultrasound examination of the prostate gland. Part 2. *J Ultrason*. 2017;17(68):43-58.
26. Ghai S, Eure G, Fradet V, et al. Assessing Cancer Risk on Novel 29 MHz Micro-Ultrasound Images of the Prostate: Creation of the Micro-Ultrasound Protocol for Prostate Risk Identification. *J Urol*. 2016;196(2):562-9.
27. Ghai S, Van der Kwast T. Suspicious findings on micro-ultrasound imaging and early detection of prostate cancer. *Urol Case Rep*. 2017;16:98-100.
28. Rohrbach D, Wodlinger B, Wen J, Mamou J, Feleppa E. High-Frequency Quantitative Ultrasound for Imaging Prostate Cancer Using a Novel Micro-Ultrasound Scanner. *Ultrasound Med Biol*. 2018;44(7):1341-1354.
29. Furlan A, Borhani AA, Westphalen AC. Multiparametric MR imaging of the Prostate: Interpretation Including Prostate Imaging Reporting and Data System Version 2. *Radiol Clin North Am*. 2018;56(2):223-238.
30. Mueller-Lisse UG, Scherr MK. Proton MR spectroscopy of the prostate. *Eur J Radiol*. 2007 ;63(3):351-60.
31. Schoots IG, Roobol MJ, Nieboer D, Bangma CH, Steyerberg EW, Hunink MG. Magnetic resonance imaging-targeted biopsy may enhance the diagnostic accuracy of significant prostate cancer detection compared to standard transrectal ultrasound-guided biopsy: a systematic review and meta-analysis. *Eur Urol*. 2015;68(3):438-50.
32. Le JD, Tan N, Shkolyar E, et al. Multifocality and prostate cancer detection by multiparametric magnetic resonance imaging: correlation with whole-mount histopathology. *Eur Urol*. 2015;67(3):569-76.
33. Simmons LA, Ahmed HU, Moore CM, et al. The PICTURE study -- prostate imaging (multi-parametric MRI and Prostate HistoScanning™) compared to transperineal ultrasound guided biopsy for significant prostate cancer risk evaluation. *Contemp Clin Trials*. 2014;37(1):69-83.
34. de Rooij M, Hamoen EH, Witjes JA, Barentsz JO, Rovers MM. Accuracy of Magnetic Resonance Imaging for Local Staging of Prostate Cancer: A Diagnostic Meta-analysis. *Eur Urol*. 2016;70(2):233-45.
35. 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;389(10071):815-822.
36. Filson CP, Natarajan S, Margolis DJ, et al. Prostate cancer detection with magnetic resonance-ultrasound fusion biopsy: The role of systematic and targeted biopsies. *Cancer*. 2016; 122(6):884-92.
37. 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.

38. 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):218-27.
39. 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.
40. 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. *Eur J Radiol*. 2018;101:17-23.
41. Outwater EK, Montilla-Soler JL. Imaging of prostate carcinoma. *Cancer Control*. 2013;20(3):161-76.
42. 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.
43. Barry MJ, Simmons LH. Prevention of Prostate Cancer Morbidity and Mortality: Primary Prevention and Early Detection. *Med Clin North Am*. 2017;101(4):787-806.