Imaging of Prostate Cancer Using ^{18}F-Choline PET/Computed Tomography

Marina Hodolič, MD, PhD[a,b,*]

KEYWORDS

• Prostate cancer • Choline • ^{18}F-choline • FCH (fluorocholine) • PET/CT

KEY POINTS

- ^{18}F-fluorocholine (FCH) PET/computed tomography (CT) may be considered a valuable imaging modality in patients with prostate cancer disease.
- Its main role is in restaging of patients with biochemical recurrence of prostate cancer disease after radical prostatectomy or external beam radiotherapy.
- ^{18}F-FCH PET/CT is strengthening its position in the initial staging, biopsy target definition, and radiotherapy planning, as well as therapy monitoring of prostate cancer disease.
- Gleason score and prostate-specific antigen value, doubling time, and velocity can influence positivity of 18F-FCH PET/CT.

In 2012, the *World Cancer Statistics* reported that lung, prostate, and colorectal cancers contributed to 42% of all cancers in men, excluding nonmelanoma skin cancer.[1] Prostate cancer is the second most frequent cancer and the sixth leading cause of cancer death in men worldwide. Despite improved methods of early diagnosis, evaluation, and management of patients with prostate cancer, in the United States approximately 1 in 10 men will ultimately die of prostate cancer.

Initiatives for screening and availability of new treatment modalities have a major impact on disease epidemiology. Approximately 68% of patients with prostate cancer are from more developed countries. Prostate cancer tends to develop in men older than age 50 years and it is diagnosed in 80% of men by the age of 80 years. It is usually slow growing and it is frequently asymptomatic. As a consequence, some men affected with this malignancy receive no diagnosis or therapy and they usually die of other unrelated causes. In the development of prostate cancer, many factors have been implicated but yet there is no established relationship between any environmental factor and the incidence or aggressive nature of prostate cancer.

CLINICAL MANAGEMENT OF PATIENTS WITH PROSTATE CANCER

In most cases, in the early stages, prostate cancer is harmless and seems to be symptom free. For this reason, sensitive diagnostic procedures are crucial for appropriate management and a good survival rate.

Prostate-specific antigen (PSA), a serum marker, can be an early clue to the presence of prostate cancer. Although a nonspecific biomarker, an elevated PSA level should lead to other diagnostic procedures. Using PSA alone, a 70% to 80% specificity and a 70% sensitivity is mediocre.[2–4] However, PSA level measurement and digital rectal examination followed by endorectal ultrasound (US) and biopsy are still basic procedures performed in patients with suspicion of prostate cancer. Ultrasound, computed tomography (CT) scan, and MR

Disclosure Statement: The author has nothing to disclose.
[a] Nuclear Medicine Research Department, Iason, Graz, Austria; [b] Department of Nuclear Medicine, Palacký University Olomouc, Olomouc, Czech Republic
* Poljanska cesta 19, Ljubljana 1000, Slovenia.
E-mail address: marina.hodolic@gmail.com

PET Clin 12 (2017) 173–184
http://dx.doi.org/10.1016/j.cpet.2016.11.004

with disseminated prostate cancer disease? In the guidelines from the European Association of Urology, 2014, there is no precise indication for choline PET/CT scans in patients with castrate-resistant prostate cancer.[7] In 2015, the Prostate Cancer Clinical Trials Working Group 2 recommended a combination of BS, CT scan, PSA measurements, and clinical findings in patients with metastatic castrate-resistant prostate cancer.[64] For this group of patients, the guidelines presented MR imaging and PET as useful techniques. The St. Gallen's Consensus Conference recommended BS and CT scan as baseline investigations. PSA should be considered for monitoring treatment response in conjunction with alkaline phosphatase and lactate dehydrogenase.[65]

Up to 45% of the patients going for choline PET/CT scans are undergoing ADT at the time of the examination. In this regard, there is a question whether ADT influences the choline uptake and, therefore, whether ADT should be withdrawn before PET. Some studies support the theory that there is no influence of ADT on the detection rate of ^{18}F-FCH PET/CT scans; therefore, it is not necessary to withdraw ADT before performing ^{18}FCH PET/CT scan.[62,66–68]

On the other hand, some investigators postulate an inhibitory effect of ADT on choline uptake and thus recommend that the choline PET scan should be performed either before starting ADT or the treatment should be interrupted for a certain amount of time before the scan.[69,70] It remains unclear if differences in choline uptake can be contributed to an effect caused by the therapeutic effect of ADT; for example, the reduced tumor volume or changes in metabolism.[71]

Patients who do not respond to ADT and who present with PSA elevation despite the ongoing ADT are the main candidates for choline PET.[62] In their study, McCarthy and colleagues[72] showed better sensitivity of an ^{18}F-FCH PET/CT scan in comparison with conventional imaging modalities (CT scan and BS) in follow-up of patients with castration-resistant prostate carcinoma. The ^{18}F-FCH PET/CT scan showed good initial concordance (81%) with BS and CT scan in the detection of active metastatic prostate carcinoma. Follow-up of the cases in which ^{18}F-FCH was initially discordant, with subsequent BS or CT scan, shows that ^{18}F-FCH is accurate in determining the presence or absence of prostate metastasis in 79% of lesions. Another group of investigators showed that the combination of decrease in PSA level and an ^{18}F-FCH PET/CT scan can be an early predictor of outcome in patients with castrate-resistant prostate cancer treated with enzalutamide.[73]

It seems that a role is still being sought for ^{18}F-FCH PET/CT scans in the therapy monitoring of patients with rising PSA after primary therapy or in cases of systemic spread of prostate cancer disease. Nevertheless, it seems that ^{18}F-FCH PET/CT scans have a role in a selected group of patients.

SUMMARY

In conclusion, an ^{18}F-FCH PET/CT scan may be considered a valuable imaging modality in patients with prostate cancer disease. Probably, its main role is in restaging of patients with biochemical recurrence of prostate cancer disease after RP or EBRT. At the same time, the ^{18}F-FCH PET/CT scan is strengthening its position in the initial staging, biopsy target definition, and radiotherapy planning, as well as therapy monitoring of prostate cancer disease. PSA value, PSAdt, and PSAve, as well as GS, can influence the positivity of ^{18}F-FCH PET/CT scans. The influence of ADT on choline uptake in patients with prostate cancer disease has not yet been precisely clarified.

Last but not least, collaboration between nuclear medicine physicians, radiologists, urologists, oncologists, and radiotherapists is crucial to the intention to help patients with prostate cancer disease.

ACKNOWLEDGMENTS

The author would like to thank Jure Fettich, MD, PhD, for his invaluable suggestions and support during writing this article; Laura Evangelista MD, PhD, for providing ^{18}F-FCH PET/CT scan examples for this article; Christoph Artner for supporting my ideas in work with ^{18}F-FCH.

REFERENCES

1. Available at: http://www.wcrf.org/int/cancer-facts-figures/worldwide-data.
2. Catalona WJ, Smith DS, Ratliff TL, et al. Measurement of prostate-specific antigen in serum as a screening test for prostate cancer. N Engl J Med 1991;324(17):1156–61.
3. Brawer MK, Chetner MP, Beatie J, et al. Screening for prostatic carcinoma with prostate specific antigen. J Urol 1992;147:841–5.
4. Roscigno M, Scattoni V, Bertini R, et al. Diagnosis of prostate cancer. State of the art. Minerva Urol Nefrol 2004;56:123–45.
5. Beauregard JM, Williams SG, Degrado TR, et al. Pilot comparison of F-fluorocholine and F-fluorodeoxyglucose PET/CT with conventional imaging in prostate cancer. J Med Imaging Radiat Oncol 2010;54:325–32.