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Comprehensive study of 18F-FECH-PET/CT imaging including the kinetic analysis in patients with primary and recurrent prostate cancer

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There is lack of studies in the literature discussing the kinetic modeling of ^{18}F-FECH-PET in patients with prostate cancer. In contrast, the kinetic analysis of ^{18}F-FDG-PET had been frequently reported and proven to be of clinical benefit in several different kinds of cancer.

Generally, kinetic modeling represents the micro molecular interactions that occur in tissue of interest. In PET examinations, the uptake mechanism is known to consist of a set of reaction pathways with multiple rate coefficients. The knowledge of theses specific elementary reactions in choline uptake may have benefits in characterizing the tumor focus from other tissues. Moreover, closer scrutiny of these interactions will help in understanding how the therapy affects the tumor focus. As a result, it might provide a major advantage in early prediction of therapy outcome.

In the light of useful results of kinetic studies of ^{18}F-FDG-PET in many different tumors, we sought to study the kinetic of ^{18}F-FECH-PET in patients with prostate cancer, including the primary and recurrent tumors.

A two-tissue compartment model is the standard methodology for the quantification of ^{18}F-FDG-PET kinetic. However, knowledge is nonexistent about application of this model in the kinetic analysis of ^{18}F-FECH-PET. Nevertheless, the two-compartment model should be the most appropriate candidate to describe the kinetic model of choline, taking into account its pathway in tumor tissue described previously in many studies.

We found that the kinetic analysis of dFECH-PET (dynamic FECH-PET) provides a novel method in prostate cancer diagnosis and may have potential value in the delineation of tumor

focus in evidence of the significant difference in k1, k3 and Fractal dimension (FD) in tumor tissue compared with normal tissue. Moreover, we found that SUV was more correlated with k1 than with k3, which demonstrates choline transport and not the metabolism is the key factor in the final uptake.

We found, however, no difference in the kinetic activities of choline between different recurrence sites including local recurrence, lymph node recurrence and bone involvement, suggesting that there is no relation between the kinetic activity of tracer and tumor sites.

In addition to kinetic analysis, we studied the normal biodistribution of choline in a random group of patients. Our results were comparable with the results of other studies performed in this setting. However, our main purpose was to identify any potential abnormal uptake caused by disorders not related with PCA and that might be confused with prostate cancer metastases. Closer scrutiny of these uptakes can improve the interpretation of PET-findings by minimizing the percentage of false positives. The secondary purpose was to reveal an additional utility of ^{18}F-FECH-PET/CT in other tumors except for prostate cancer. As a result, we found that 8 % of patient in the selected group had demonstrated findings not caused by prostate cancer, including sarcoidosis, thymus cancer, SCLC, venous aneurysm, meningioma, and inflammatory changes.

We also aimed to demonstrate the extent that the sensitivity of ^{18}F-FECH-PET/CT varies with PSA value. Indeed, some studies were previously performed to disclose the role of PSA level in predicting the likelihood of choline-PET to be positive. However, they were mostly using ^{11}C labeled choline. A small number of studies focused on ^{18}F-FECH-PET/CT.

For this purpose, patients with different initial therapies and different PSA values were investigated. We found that PSA-value played a determinant role in PET- imaging outcomes in evidence of the linear correlation between detection rate and trigger PSA value. This result was expected. However, in our opinion other factors like initial therapy should also be considered among factors affecting the ^{18}F-FECH-PET/CT sensitivity. Moreover, we found a latent link between recurrence-type and initial therapy, which could play a guiding role in selecting the appropriate diagnostic methods.

We additionally investigated whether ^{18}F-FECH-PET/CT is capable of assessing the bone status in an adequate way or whether it requires a supplementary test. The analysis was performed by comparing the imaging with a standard bone scan. This issue was still blurred considering the lack of such comparisons. So we selected from the previous group those

patients, who underwent both modalities (^{18}F-FECH-PET/CT and bone scan) in a short interval, and the advantages and disadvantages of each test were discussed. For this purpose, the skeleton was divided into five anatomical regions to simplify the comparison of both findings in matching regions.

^{18}F-FECH-PET/CT was more specific and might play a promising role in detecting bone marrow metastases. However, it was less sensitive and the outcome is likely to be affected by antihormonal therapy.

The lesion-based results were somewhat conflicting with the patient-related results. We found that ^{18}F-FECH-PET/CT was superior in all anatomical regions compared with BS except in thorax. This result was partially attributed to the guiding role of CT in ^{18}F-FECH-PET/CT.

In view of the discrepant strength and weakness points of both examinations, a combination between both modalities in the equivocal cases is recommended.

Moreover, we conducted a quantitative analysis of the association between choline uptake and HU. The result was consistent with a previous study that reported a negative correlation between SUV value and HU value. This finding makes the ^{18}F-FECH-PET/CT principally invalid in monitoring the progress of bone involvement.