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Skeletal imaging of multiple myeloma with ^{18}F-FDG and ^{18}F-NaF dynamic PET/CT

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The aim of the present study was to compare the performance of ^{18}F-FDG PET/CT and ^{18}F-NaF PET/CT in multiple myeloma (MM) patients regarding lesion detection and, further, to assess the potential added value of ^{18}F-NaF PET in MM diagnostic approach. For this reason dual tracer ^{18}F-FDG and ^{18}F-NaF PET/CT studies in 80 MM patients (67 newly diagnosed MM patients and 13 patients with recurrent disease) were performed, with ^{18}F-FDG PET/CT serving as reference. Moreover, given the limited knowledge regarding the kinetics of both tracers in the malignancy, ^{18}F-FDG and ^{18}F-NaF kinetic studies, based on dynamic PET/CT exams of the pelvis, were performed. Tracers' kinetics were evaluated with application of two-tissue compartment modelling, which is the standard methodology for quantification of ^{18}F-FDG and ^{18}F-NaF kinetics. Further, a non-compartmental approach based on fractal dimension was applied.

The present results showed that ^{18}F-FDG PET/CT could detect in total 525 MM-indicative lesions, 289 of which (55%) correlated with osteolytic findings in low-dose CT. ^{18}F-NaF PET/CT detected 263 of the 525 lesions, which were ^{18}F-FDG positive (50%). Moreover, ^{18}F-NaF PET/CT demonstrated a low specificity, regarding identification of myelomatous osseous lesions, due to the fact that the tracer accumulates in every site of increased osteoblastic activity. Therefore, it is concluded that the additional PET/CT scanning with ^{18}F-NaF doesn't add significant information to the diagnostic approach of MM patients, who have already gone through ^{18}F-FDG PET/CT. The main potential contribution of ^{18}F-NaF PET/CT in the malignancy is that it provides general information regarding bone remodelling and the patient´s skeletal history.

Kinetic analysis of the dynamic PET/CT data, derived from ^{18}F-FDG and ^{18}F-NaF PET/CT studies of the pelvis, demonstrated no significant correlation between kinetic parameters and SUVs for both tracers. Our data indicate that these parameters are tracer specific and provide different information regarding pathological skeletal processes that take place in MM.

The second part of the study involved only the 67 patients with newly diagnosed MM and focused on the correlation between ^{18}F-FDG PET/CT information and patient clinical/laboratory parameters of established clinical significance and prognostic value in MM (β2-microglobulin, thrombocytes, serum albumin, Hb, LDH, CRP etc). The acquired results demonstrated that patients with a mixed tracer uptake in ^{18}F-FDG PET/CT had the highest malignant plasma cell infiltration rate of the bone marrow, thus, the highest tumor burden, followed by those patients with a diffuse pattern of intense ^{18}F-FDG bone marrow uptake. On the other hand, subjects with a negative PET/CT scan revealed the lowest degree of plasma cell concentration in the bone marrow. This result is of significance, since it highlights the role of ^{18}F-FDG PET as an indicator of disease burden; patients presenting with a mixed pattern of ^{18}F-FDG bone marrow uptake are expected to have a high degree of infiltration of the bone marrow by malignant plasma cells. Moreover, a significant correlation between the ^{18}F-FDG parameters ($SUV_{average}$, SUV_{max}, V_B, k_1, k_3, influx and FD) and bone marrow infiltration rate by malignant plasma cells was demonstrated, a result that stresses the capacity of ^{18}F-FDG PET as a molecular imaging biomarker.

Correlation analysis revealed significant but relatively weak correlations between several ^{18}F-FDG parameters derived from the bone marrow of the os ilium, and established prognostic factors in MM. SUV, the most popular semi-quantitative PET parameter and a reflector of global tracer uptake was found to correlate positively with the levels of β2-microglobulin and negatively with the levels of thrombocytes, albumin and Hb. Furthermore, SUVs were higher in patients with hypoalbuminemia, anemia, pathologically elevated CRP and pathological κ/λ ratio.