Purpose:
The differentiation between the residual tumor activity and the osseous reaction to the tumor is essential for therapy assessment of bone metastases. The 18-F-Sodium Fluoride (NaF) uptake reflects the osteoblastic process, while the FDG uptake reflects the tumor metabolism. The purpose of this study was to evaluate the assessment of treatment response with the kinetic analysis of concurrent NaF/FDG PET/CT images for specific clinical cases.

Methods:
Three prostate adenocarcinomas were treated with chemotherapy and imaged twice with NaF/FDG PET/CT: a baseline scan and a second scan after four weeks of chemotherapy. The NaF/FDG PET/CT imaging started with NaF injection, followed by 100 min dynamic PET imaging. Next, FDG was injected and followed by an additional 45 min of dynamic PET imaging. Macroparameters K_NaF and K_FDG (defined as $K=K1\times k3/(k2+k3)$) were obtained by compartmental kinetic analysis. The accuracy of the kinetic parameter estimations was evaluated with simulations. Bone metastases were segmented (29 total). The ratio of mid-therapy to pre-therapy mean K_FDG and K_NaF parameters, which measured the response to therapy, was calculated for each metastasis.

Results:
The simulations revealed that the K_NaF and K_FDG estimations are highly correlated to the simulated value ($r=0.9$) while an estimated error is 50%. The K_FDG response and the K_NaF response are moderately correlated ($r=0.7$), but the mean K_FDG response over all the metastases is 0.7 while the mean K_NaF response is 0.9. The patterns in K_FDG and K_NaF parametric images are similar, but displaced and slightly distorted.

Conclusions:
Tumor metabolism and bone repair process can be imaged separately at the same time point using the presented imaging protocol, which was validated with simulations. The addition of FDG PET imaging to the osseous NaF PET imaging provides additional information to treatment response and has the potential to improve the assessment of bone metastasis in therapy.