Targeted alpha therapy (TAT) using $^{225}$Ac-PSMA ligands is a promising therapy option for advanced metastatic castration-resistant prostate cancer (mCRPC) [1]. The $^{225}$Ac decay chain shows a noticeable gamma emission (440 keV, 25.9%; 218 keV, 11.4%). However, recommended low therapeutic activities (4–8 MBq) limit the clinical applicability of SPECT [2], although initial attempts for $^{225}$Ac imaging exist [3, 4]. Particularly quantitative SPECT is a vital tool to assess dosimetry and therapy response. While the 218-keV-peak is characterized by a lower branching ratio and a higher scatter fraction, SPECT imaging of high-energy gammas such as 440 keV causes a complex detector point spread function (PSF) [5].

In this study, we would like to demonstrate the general feasibility of image-based dosimetry for $^{225}$Ac radionuclide therapy using quantitative $^{225}$Ac SPECT. For a mCRPC patient (65 years), imaging of the abdomen was performed 24 h p. i. of 8.1 MBq $^{225}$Ac-PSMA-I&T on a Siemens Symbia Intevo T16 SPECT/CT (440 keV (width, 20%), lower adjacent window (width, 10%), HEGP collimator, 16 projections/head, 128 × 128 pixel, 210 s/projection). Reconstruction was carried out via a MAP algorithm (30i1s) [6], including CT-based attenuation and dual-energy-window scatter correction and a simulated distance-dependent 2D PSF model (SIMIND). Final absorbed dose assessment was performed by combining the single $^{225}$Ac image with the effective half-life information determined from a previous $^{177}$Lu-PSMA-I&T imaging sequence [7]. This resulted in an absorbed dose of 0.18 and 0.17 Sv RBE = 5 /MBq for the left and right kidney, respectively, compared with 0.27 and 0.24 Gy/GBq for the preceding $^{177}$Lu cycle (6.2 GBq). A comparison with the pre-therapy $^{18}$F-PSMA-I&T PET/CT demonstrates that $^{225}$Ac SPECT imaging for this patient was able to locate a small lesion in the right hip. The $^{225}$Ac-absorbed dose was determined as 0.26 Sv RBE = 5 /MBq, compared with 0.35 Gy/GBq for $^{177}$Lu-PSMA-I&T.

Our analysis demonstrates the feasibility of dosimetry for $^{225}$Ac-PSMA-I&T, which provides further insights into theranostic approaches using TAT in mCRPC patients.
Funding  Open Access funding enabled and organized by Projekt DEAL.

Compliance with ethical standards

All procedures performed in this study involving human participants were in accordance with ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The retrospective evaluation was approved by the local ethic committee (20-178). Written informed consent was obtained prior to the exam.

Conflict of interest  The authors declare that they have no conflict of interest.

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