Abstract

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Patient-Specific Dosimetry Using Pretherapy [124I]m-iodobenzylguanidine ([124I]mIBG) Dynamic PET/CT Imaging Before [131I]mIBG Targeted Radionuclide Therapy for Neuroblastoma.

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Abstract

PURPOSE: Iodine-131-m-iodobenzylguanidine ([^{131}I]mIBG)-targeted radionuclide therapy (TRT) is a standard treatment for recurrent or refractory neuroblastoma with response rates of 30-40 %. The aim of this study is to demonstrate patient-specific dosimetry using quantitative [^{124}I]mIBG positron emission tomography/X-ray computed tomography (PET/CT) imaging with a GEometry ANd Tracking 4 (Geant4)-based Monte Carlo method for better treatment planning.

PROCEDURES: A Monte Carlo dosimetry method was developed using the Geant4 toolkit with voxelized anatomical geometry and source distribution as input. The presegmented hybrid computational human phantoms developed by the University of Florida and the National Cancer Institute (UF/NCI) were used as a surrogate to characterize the anatomy of a given patient. S values for I-131 were estimated by the phantoms coupled with Geant4 and compared with those estimated by OLINDA|EXM and MCNPX for the newborn model. To obtain patient-specific biodistribution of [^{131}I]mIBG, a 10-year-old girl with relapsed neuroblastoma was imaged with [^{124}I]mIBG PET/CT at four time points prior to the planned [^{131}I]mIBG TRT. The organ- and tumor-absorbed doses of the clinical case were estimated with the Geant4 method using the modified UF/NCI 10-year-old phantom with tumors and the patient-specific residence time.

RESULTS: For the newborn model, the Geant4 S values were consistent with the MCNPX S values. The S value ratio of the Geant4 method to OLINDA|EXM ranged from 0.08 to 6.5 of all major organs. The [^{131}I]mIBG residence time quantified from the pretherapy [^{124}I]mIBG PET/CT imaging of the 10-year-old patient was mostly comparable to those previously reported. Organ-absorbed dose for the salivary glands was 98.0 Gy, heart wall 36.5 Gy, and liver 34.3 Gy, while tumor-absorbed dose ranged from 143.9 to 1,641.3 Gy in different sites.

CONCLUSIONS: Patient-specific dosimetry for [^{131}I]mIBG TRT was accomplished using pretherapy [^{124}I]mIBG PET/CT imaging and a Geant4-based Monte Carlo dosimetry method. The Geant4 method with quantitative pretherapy imaging can provide dose estimates to normal organs and tumors with more realistic simulation geometry, and thus may improve treatment planning for [^{131}I]mIBG TRT.