Effect of Patient Morphology on Dosimetric Calculations for Internal Irradiation as Assessed by Comparisons of Monte Carlo Versus Conventional Methodologies.

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Abstract

Dosimetric calculations are performed with an increasing frequency before or after treatment in targeted radionuclide therapy, as well as for radiation protection purposes in diagnostic nuclear medicine. According to the MIRD committee formalism, the mean absorbed dose to a target is given by the product of the cumulated activity and a dose-conversion factor, known as the S factor. Standard S factors have been published for mathematic phantoms and for unit-density spheres. The accuracy of the results from the use of these S factors is questionable, because patient morphology can vary significantly. The aim of this work was to investigate differences between patient-specific dosimetric results obtained using the Monte Carlo method and results obtained using S factors calculated on standard models.

Methods: The CT images of 9 patients, who ranged in size, were used. Patient-specific S factors for 131I were calculated with the MCNPX2.5.0 Monte Carlo code using a tool for personalized internal dose assessment, OEDIPE; standard S factors from OLINDA/EXM were compared against the patient-specific S factors. Furthermore, realistic biodistributions and cumulated activities for normal organs and tumors were used, and mean organ- and tumor-absorbed doses calculated with OEDIPE and OLINDA/EXM were compared. Results: The ratio of the standard and the patient-specific S factors were between 0.49 and 1.84 for a target distant from the source for 4 organs and 2 tumors studied as source and targets. For the case of selfirradiation, the equivalent ratio ranged between 0.45 and 2.47 and between 1.00 and 1.06 when mass was corrected. Differences in mean absorbed doses were as high as 140% when realistic cumulated activity values were used. These values decreased to less than 26% in all cases studied when mass correction was applied to the self-irradiation given by OLINDA/EXM.

Conclusion: Standard S factors can yield mean absorbed doses for normal organs or tumors with a reasonable accuracy (26% for the cases studied) as compared with absorbed doses calculated with Monte Carlo, provided that they have been corrected for mass.

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