Ruprecht-Karls-Universität Heidelberg
Medizinische Fakultät Mannheim
Dissertations-Kurzfassung

Development and evaluation of techniques for accurate [18F]Fluorodeoxyglucose pharmacokinetic analyses in patient

Autor: Flavia Juliana Molina Duran
Institut / Klinik: Klinik für Strahlentherapie und Radioonkologie
Doktorvater: Prof. Dr. F. Wenz

Characterization of tumors for diagnosis, treatment planning and therapy monitoring are important for improving cancer treatment. Therefore, dynamic FDG-PET measurements and computation of parameter maps visualizing FDG transport and metabolism by pharmacokinetic modeling is needed. In this thesis, quantification of absolute activity concentration in brain metastasis was investigated and implemented. Therefore, detailed characterization measurements for a Biograph mCT PET/CT system were performed using ^{18}F. These include a) the spatial resolution for the system in an extended range of off axis distances for two different zoom sizes, using a self-designed phantom, b) the image quality evaluation influenced by different activity concentrations, time acquisition and reconstruction parameters, as for example, the use of time-of-flight method and the quantification of differences between analytical (back projection) and iterative algorithms (order subset expectation maximization and point spread function); the influence of matrix size and post filtering methods were also considered. c) A novel theoretical model for accurate determination of recovery coefficients (RC) for cylindrical structures was developed for partial volume correction of the arterial input function for dynamic imaging. To validate the model, four cases were evaluated performing the measurement of cylinder with different sizes using an in-house adaptation of the Jaszczak phantom. The evaluation and improvement of a two compartmental model for pharmacokinetic analysis, using dynamic imaging from study patients with brain metastases, was assessed applying the proposed RC correction model.
The results showed quasi-homogeneous resolution for both zooms in all the evaluated directions (axial, transverse radial and transverse tangential). Based on image quality results an optimal set of reconstruction parameters was established, taking into account acceptable levels of image noise and the needed convergence of iterative algorithms for quantitative imaging. The arterial input function could be improved through the use of dynamic imaging and applying our proposed RC model.
The basis of dynamic analyses and follow-up for brain metastases monitoring using a PET/CT system as a complementary diagnostic tool were established. Furthermore, this study contributed to the optimization of actual, clinically used diagnostic protocols.