CT- versus coregistered FDG-PET/CT-based radiation therapy plans for conformal radiotherapy in colorectal liver metastases: a dosimetric comparison

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Background. Currently, liver cancer caused by colorectal cancer metastases (CRLM) remains one of the most challenging and progressive issues in oncology. Despite significant advances in diagnosis and treatment, unresectable CRLM continues to pose a challenge to medical practice due to its aggressiveness and limited intervention methods. Specifically, accurate delineation of the gross tumor volume (GTV) in unresectable CRLM is crucial for radiotherapeutic treatment planning and determining critical organ doses.

Modern cancer management methods include the use of computed tomography (CT) and positron emission tomography with [(18)F]-fluorodeoxyglucose (FDG-PET/CT), which allow for a more precise characterization of the tumor process's nature and extent. However, despite improved visualization methods, challenges still exist in defining GTV boundaries, especially in cases with complex anatomical localizations and neighboring tissues.

In this context, this study aims to compare the results of GTV delineation in unresectable CRLM using two methods - CT and coregistered FDG-PET/CT. It is hypothesized that integrating FDG-PET/CT data can enhance the accuracy of tumor extent determination and thus contribute to more effective radiotherapeutic treatment planning. Furthermore, the potential to pre-assess GTV using FDG-PET/CT may help avoid radical interventions that could prove futile in cases of unresectable CRLM.

Purpose of the study: Our aim was to compare computed tomography (CT) and coregistered [(18)F]-fluorodeoxyglucose positron emission tomography CT-(FDG-PET/CT) based delineation of gross tumor volume (GTV) in unresectable colorectal liver metastasis (CRLM).

Materials and methods. Fifty-four patients with unresectable CRLM were enrolled but 16 were excluded due to detection of additional hepatic metastases in ten on PET/CT scans, precluding radiotherapy because of transcendent critical organ doses beyond tolerable limits; and of extrahepatic metastases in six. For 38 eligible patients, both CT and PET/CT images were acquired, and two 3D conformal plans were made using the CT and FDG-PET/CT fusion data sets. Radiotherapy plans (RTP) and doses to critical organs were analyzed.

Results. Comparisons between two RTPs revealed need for change in GTV in 31 of 38 analyzable patients (81.6 %). In 25 (65.8 %) patients, GTV was significantly increased, with a median of 33.2 % ($p < 0.001$), whereas median 12.8 % decrease in six (15.8 %) ($p < 0.001$). There were no clinically meaningful differences in critical organ doses.

Conclusion. Coregistered FDG-PET/CT may improve delineation of GTV and theoretically reduce the likelihood of geographic misses in unresectable CRLM. Additionally, integration of FDG-PET/CT in the initial assessments of CRLM may spare almost one third of patients from potentially futile radical interventions.

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