3D Personalized dosimetry for Yttrium-90 microsphere radioembolization of liver tumors: feedback and clinical cases

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Introduction:

Today, dose computation for Selective internal radiation therapy (SIRT) is based on methods easy to apply clinically. Several studies highlight dose-effect relationship for SIRT. As a result, interest enhances for advanced calculations and dose analysis tools as the ones used in external beam radiation therapy (EBRT). The Nuclear Medicine department of Montpellier University Hospital (MUH) implemented a new system to meet this need. This study describes the methodology applied, its interest and the questions raised illustrated by some clinical cases.

Material and methods:

For every patient treated by SIRT, the dosimetry referred as "standard" applied at MUH follows the method described by Garin *et al.* [1]. This is based on the partition model for which the volumes of interest are defined using Syngo® software (Siemens, Erlangen, Germany) on SPECT images acquired after the injection of macro-aggregates of albumin (MAA) labelled with $^{99}Tc^{m}$. Recently, the implementation of a treatment planning system (TPS), PLANET® Dose (DOSIsoft, Cachan, France), allows to perform dosimetry at the voxel level. This is done through two major steps: predictive dosimetry based on MAA-SPECT images and *in vivo* control dosimetry using PET images acquired after the injection of yttrium-90 (^{90}Y) microspheres *(figure 1)*. Dose distribution is especially evaluated for tumoral and non-tumoral liver delineated on the injected CT or MR images by the radiology team. Dose computation rests on a convolution method based on voxel S factors. Pre and post treatment dosimetries are analyzed by the mean dose to the volume, the dose-volume histograms (DVH) and the isodose curves.

Results:

The comparison between both dosimetric approaches (standard and at the voxel level) pointed out some differences. This particularly allowed to highlight the TPS contribution according to various aspects that were observed through clinical cases.

A first aspect is related to the volume definition (functional only vs. anatomical and/or functional) for which the TPS contribution is especially interesting for complex clinical cases (multiple tumor sites, heterogeneous or partially targeted lesions, liver failure). This kind of system then allows dose evaluation in any compartment (volume at risk, portal vein thrombosis, multiple lesions, viable tumor, etc.).

Moreover, voxelized dosimetry allows to analyze dose distribution uniformity with advanced tools (isodoses, DVH, etc.) in order to better assess areas of over/under dosing.

Finally, being able to perform post-treatment dosimetry in order to know the real delivered dose and to sum several treatment sessions can play an important role in the patient therapeutic care.

Conclusion:

Integrating a TPS like the ones used in EBRT in the SIRT process allowed to increase the medical team confidence and accuracy in the prescription of the activity to administer and to better control the dose delivered during the treatment. Setting up these new tools open the way to a more advanced personalization of this therapy.

Reference:

[1] Garin E, Lenoir L, Rolland Y, Edeline J, Mesbah H, Laffont S, et al. Dosimetry Based on 99mTc-Macroaggregated Albumin SPECT/CT Accurately Predicts Tumor Response and Survival in Hepatocellular Carcinoma Patients Treated with 90Y-Loaded Glass Microspheres: Preliminary Results. *J Nucl Med*, 2012;53(2):255–63.

Key words:

Selective internal radiation therapy - Radioembolization - Dosimetry – Liver tumor – ^{90}Y microspheres

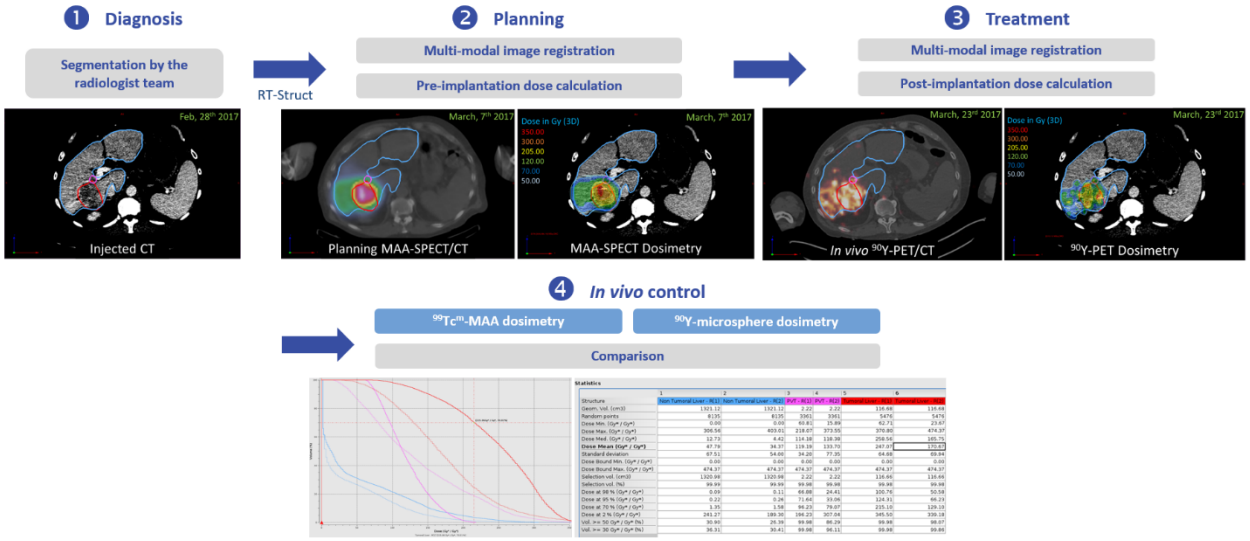

Figure 1: Workflow of pre and post-treatment dosimetry at the voxel level applied at the University Hospital of Montpellier using a treatment planning system. The results are presented for the tumoral liver (in red), the portal vein thrombosis (pink) and the non-tumoral liver (blue).