Analysis of differences between ^{99m}Tc-Macroaggregated Albumin-SPECT and ^{90}Y-Microsphere-PET dosimetry

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Objectives

The aim of this study is to analyze the differences between ^{99m}Tc-MAA-SPECT and ^{90}Y-microsphere-PET based dosimetry at the voxel level using both patient and phantom dose data. Particularly, distinguishing the uncertainties related to SPECT/PET imaging differences (spatial resolution, partial volume effect, noise) and to clinical aspects (catheter positioning, modified vascularization, MAA/microsphere distribution).

Methods

Sixteen hepatocellular carcinoma patients treated with ^{90}Y-glass microsphere radioembolisation were included in this study. For each patient, predictive and *in vivo* absorbed doses to tumor and normal liver were calculated. The mean (± standard deviation) administered activity was 3.8 GBq (±1.6) for a mean tumor volume of 575 mL (±436mL). A phantom study was also conducted on a 3D-printed liver phantom (*1*) to assess imaging-related dose differences. Measurements were performed with ^{99m}Tc and ^{90}Y injected each time into two 40 mm diameter spheres: one considered as a simple homogeneous lesion and one considered as a necrotic lesion with an inner 25 mm diameter solid sphere.

Doses for both patient and phantom studies were calculated using a dedicated software (PLANET® Dose, DOSIsoft, Cachan, France). Doses were computed using a convolution method based on voxel-S factors. In addition to the tumor average dose (D_{avg}), dose metrics extracted from dose volume histograms were analyzed: minimum dose to 70% and 50% of the tumor volume (D_{70} and D_{50}) and percentage of the tumor volume receiving at least 205 Gy (V_{205}), as recommended in the literature for glass-microsphere treatments (*2*). Difference and correlation between predictive and absorbed doses to tumor and normal liver were assessed using a paired Student's *t* test and Pearson's correlation coefficient.

Spatial concordance analysis at the voxel level between MAA and microsphere distributions on the patient cohort is ongoing. This should provide additional information to better understand the part of dose differences related to clinical factors.

Results

Dose results showed a good correlation between predictive and post-treatment dosimetry (*Table 1*). However, difference between ^{99m}Tc-MAA SPECT and ^{90}Y-microsphere PET based dosimetry was significant for all tumor and normal liver dose metrics considered. The ^{90}Y-microsphere-PET tendency to underestimate ^{99m}Tc-MAA-SPECT based doses was also observed on the liver phantom.

Preliminary results indicate that the largest dose discrepancies can be explained by clinical differences in terms of administration procedure and particle distribution. This will be further analyzed with spatial distribution analysis.

	^{99m}Tc-MAA (mean±SD)	**^{90}Y-Microsphere (mean±SD)**	**Student test (*P*)**	**Pearson's correlation coefficient**
D_{avg} (Gy)	190 ± 78	160 ± 79	0.004	0.90 (P=10^{-6})
D_{70} (Gy)	125 ± 57	93 ± 42	0.005	0.74 (P=$7*10^{-4}$)
D_{50} (Gy)	184 ± 84	143 ± 66	0.002	0.85 (P=10^{-5})
V_{205} (%)	38 ± 26	27 ± 20	0.03	0.72 (P=0.001)
$D_{avg\text{-}NL}$ (Gy)	41 ± 13	36 ± 13	0.009	0.86 (P=10^{-5})

Table 1: ^{99m}Tc-MAA-SPECT and ^{90}Y-microsphere-PET based dose results for the 16 treatments analyzed. SD=standard deviation, NL=normal liver

Conclusions

The overall good correlation observed between predictive and post-treatment dosimetry confirm the MAA predictive value. The ^{90}Y-microsphere-PET tendency to underestimate ^{99m}Tc-MAA-SPECT doses was also observed on phantom measurements and seem related mainly to imaging factors.

1. Gear JI, Cummings C, Craig AJ, et al. Abdo-Man: a 3D-printed anthropomorphic phantom for validating quantitative SIRT. EJNMMI Phys. 2016;3(1):17.
2. Garin E, Lenoir L, Rolland Y, et al. 99mTc-MAA SPECT/CT based dosimetry accurately predicts tumour response and survival in hepatocellular carcinoma patients treated with 90Y-loaded glass microspheres: preliminary results. J Nucl Med. 2012;53:255–263.