Predictive Value of ^{99m}Tc-MAA-based Dosimetry in Personalized ^{90}Y-SIRT planning for Liver Malignancies

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Supplemental:

Absorbed dose calculation:

The dosimetry calculations were performed using a self-developed MATLAB code (MATLAB (2021a), Natick, Massachusetts: The MathWorks Inc) according to the following pipeline, based on the calculations described by Moran et al. [40]:

a) 3D-voxel activity maps are calculated for both ^{99m}Tc-MAA and ^{90}Y SPECTs using a self-calibration factor (administered activity/total counts within the liver in the SPECT image) [26, 40-42]. The initial activity in each voxel comes as:

$$A_{vox}(x) = \frac{C_{vox}(x)(1 - \mathrm{LSF} - \mathrm{Res})\mathrm{A}^{90\mathrm{Y}}}{C_{WL}(x)} \quad (1)$$

Where x can be ^{90}Y or ^{99m}Tc-MAA calibrated images, Res is the residual activity and WL refers to the whole-liver segment.

b) The total number of disintegrations in a voxel can be calculated under (1) as:

$$\widetilde{\mathrm{A}}_{\mathrm{vox}}(x) = 1.443 \cdot T_{1/2}(^{90}Y) \cdot A_{vox}(x) \quad (2)$$

c) 3D-voxel absorbed dose maps are calculated based on the LDM. Since this model presumes that the kinetic energy of every beta emission is deposited within the voxel where it occurs (target = source), the absorbed dose in each voxel is calculated by multiplying the cumulative activity within the voxel ($\widetilde{\mathrm{A}}_{\mathrm{vox}}$) by a constant scalar factor (S value).

$$D_{\mathrm{vox_t}}(x) = \tilde{A}_{\mathrm{vox_s}}(x) \times S(\mathrm{vox}_t \leftarrow \mathrm{vox}_s)\big|_{t=s} \quad (3)$$

The S value can be calculated as:

$$S(\mathrm{vox}_t \leftarrow \mathrm{vox}_s)|_{t=s} = \left.\frac{\langle E_\beta(^{90}Y)\rangle}{M_{\mathrm{vox}_t}}\right|_{t=s} \quad (4)$$

M_{vox} stands for the mass of the voxel and $\langle E_\beta(^{90}Y)\rangle$ for the averaged beta energy deposited per disintegration, which is calculated under (4).

d) Simplifying the equations, the 3D-voxel dose maps can be calculated as:

$$D_{\mathrm{vox}}(x) = 2.14 \cdot 10^{-4} \cdot T_{1/2}(^{90}Y) \cdot A_{vox}(x) \quad (5)$$

Where D_{vox} is expressed in Gray (Gy), $T_{1/2}(^{90}Y)$ in seconds (s) and A_{vox} in giga-becquerel (GBq).

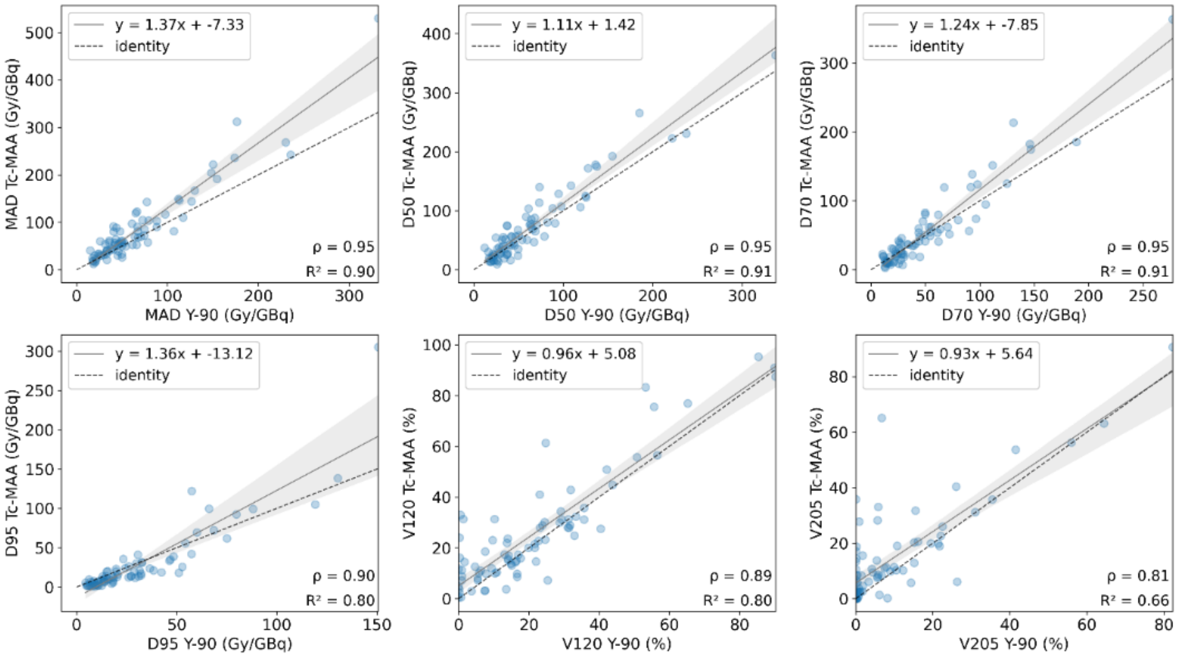

Fig. S1 Correlations plots for different dosimetry metrics derived from TL: mean dose (MAD), D50 and D70 (top) and D95, V120 and V205 (bottom). All points are shown

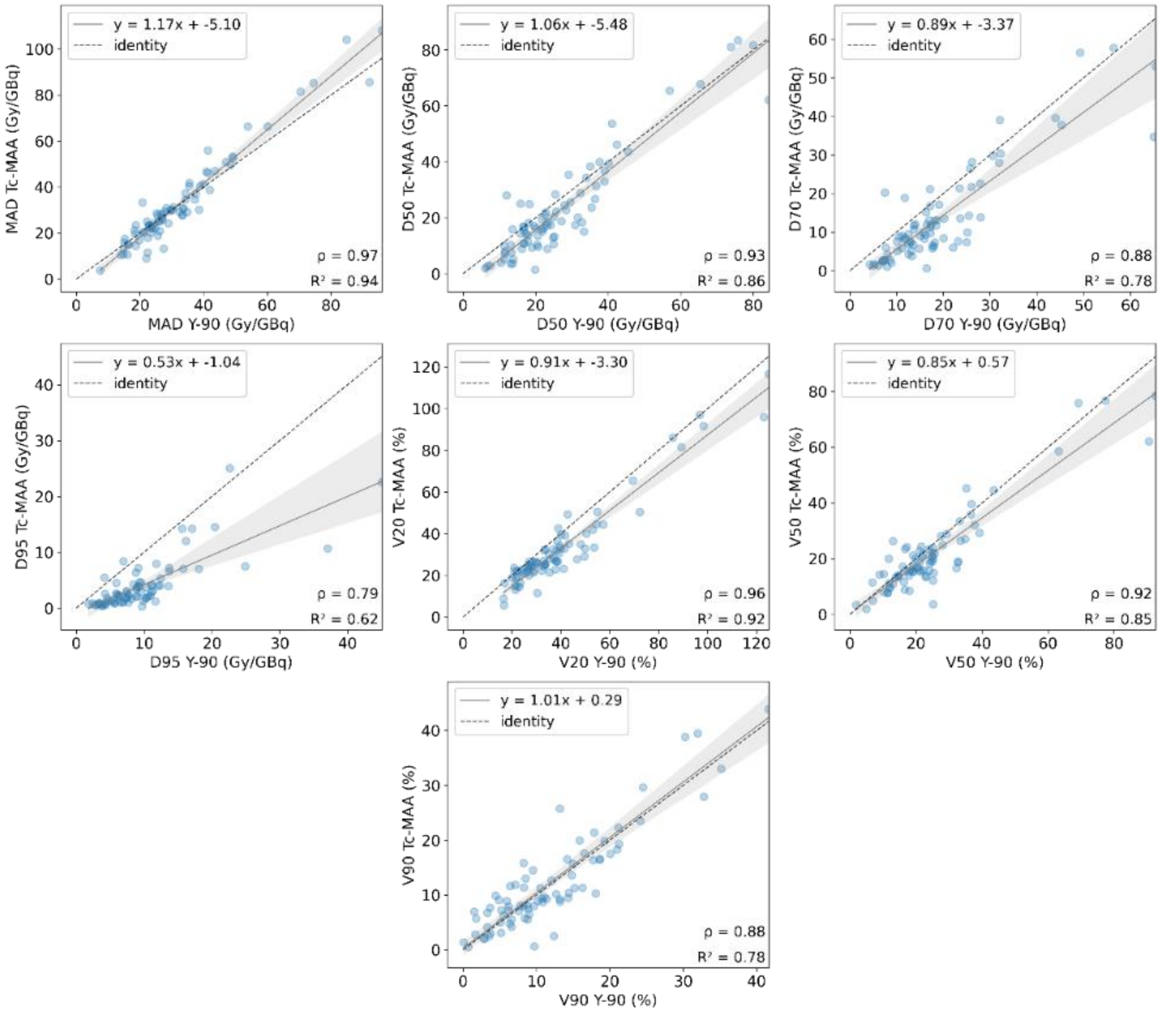

Fig. S2 Correlations plots for different dosimetry metrics derived from NTLt: mean dose (MAD), D50 and D70 (top) and D95, V50 and V90 (bottom). All points shown

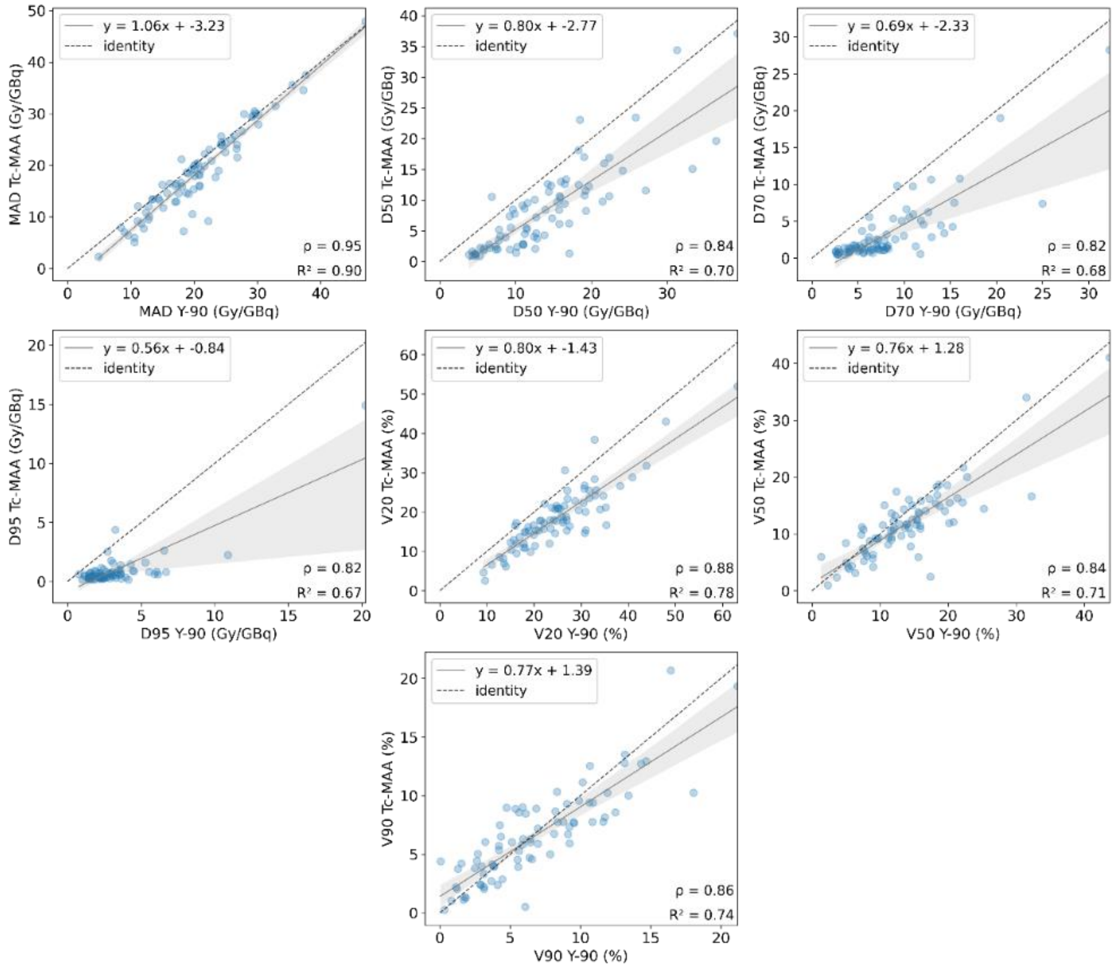

Fig. S3 Correlations plots for different dosimetry metrics derived from NTLw: mean dose (MAD), D50 and D70 (top) and D95, V50 and V90 (bottom). All points shown

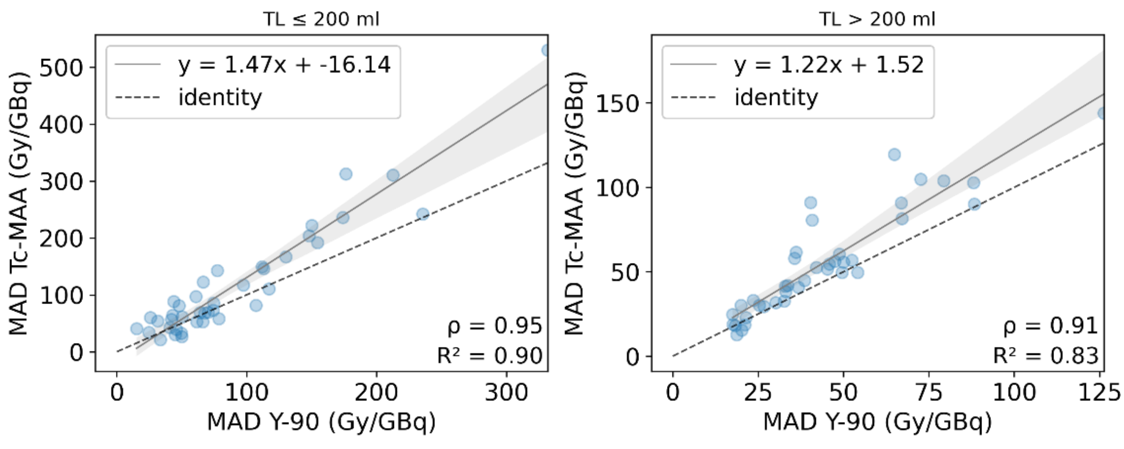

Fig. S4 Correlation plots between MAD from simulation (Tc-MAA) and therapy (90Y) for TL < 200 ml and TL > 200 ml

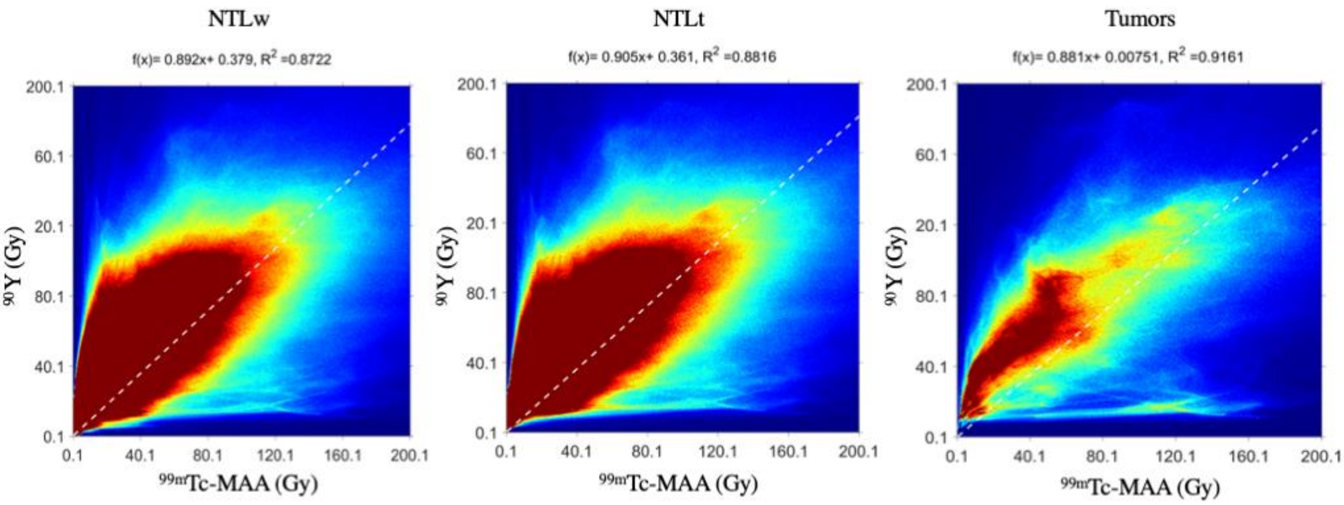

Fig. S5 Joint histograms for simulation and therapy from NTLw, NTLt and tumors. The fitted line is showed as a dashed line, while the regression model is shown on top of each graph