Y-90 Radioembolization Dosimetry Prediction by C-arm CT with PET Confirmation

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Introduction

Y-90 radioembolization is a targeted liver therapy for liver tumors, most often, in hepatocellular carcinoma (HCC) patients who are not surgical resection candidates or as a bridge to transplantation.

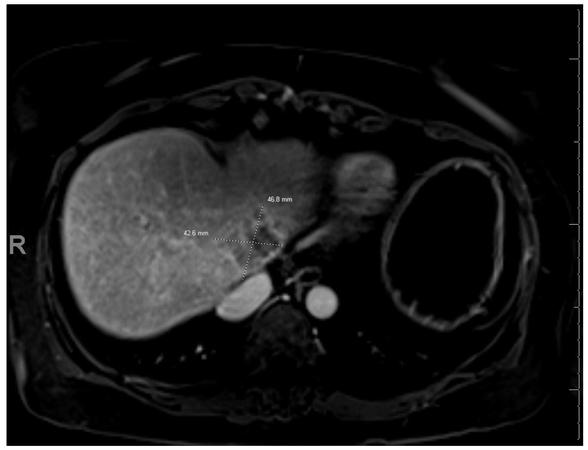


Figure 1. MR T1 post contrast sequence of HCC

Figure 2. IR Hepatic Angiogram of HCC

Figure 3. C-arm CT of HCC with Dosimetry segmentation

Rationale

Conventionally, Y-90 dose prediction for glass microsphere administration is obtained using a medical internal radiation dose (MIRD) activity model - a volumetric calculation that uses a known relationship of Y-90 dose to the mass of treated liver. This model is widely adopted and has a documented safety profile. However, it is not tumor-specific and assumes a uniform distribution of dose activity within the liver. Refined dose prediction can be made using a multicompartment partition model utilizing differential particle distribution within tumor and non-tumor liver on Tc-99m MAA SPECT. Aside from being time-intensive and technically-demanding, this method assumes that MAA and Y-90 spheres behave similarly, and inherent errors in calculation can occur secondary to factors such as variable MAA particle size and labeling instability.

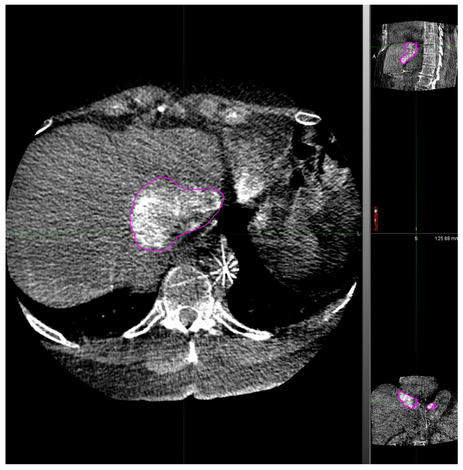
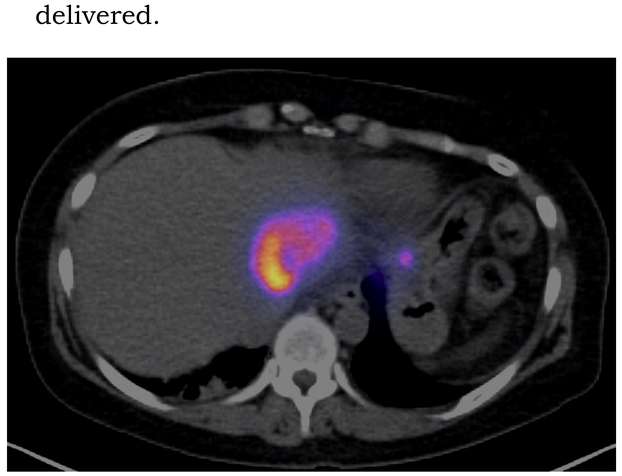


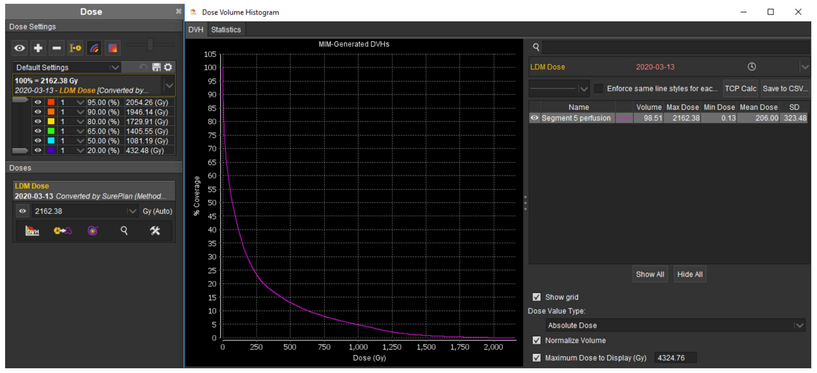
Figure 4. NM Y-90 PET of HCC

Figure 5. Dosimetry prediction calculation with Dose Volume Histogram

Methodology

This is a proof-of-concept study to evaluate Y-90 dose prediction based on differential enhancement. We developed a model utilizing the flow of intra-arterial contrast based on differential Hounsfield units from C-arm CT during mapping to estimate dose. Patients receive the current standard of care with MAA mapping, SPECT-CT, and conventional-dose calculation. A PET-CT is performed after Y-90 therapy to quantify dose delivered.





Conclusion

We believe that though Tc-99m MAA may be used to estimate radioembolization dose, it is an imperfect and complex method. In our study, we attempt to improve and simplify dose prediction utilizing differential enhancement on C-arm CT, then applying high-resolution imaging of PET-CT to define the relationship between enhancement and received dose.

References

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