Relationship Between Yttrium-90 Radioactivity Distribution and Treatment Response in Transarterial Radioembolization of Hepatocellular Carcinoma

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INTRODUCTION

• Transarterial radioembolization (TARE) is a treatment for hepatocellular carcinoma (HCC) that takes advantage of the hypervascular nature of most HCC (Figure 1).

• Irradiated microspheres (glass or resin) are deposited into the target segment/lobe through the hepatic artery and ultimately simultaneously embolize and deliver radiation to the target area.

• Yttrium-90 (Y90) PET and SPECT are used immediately post treatment to assess radiation distribution throughout the body.

• Follow up imaging is not useful to determine treatment response until at least one month post-treatment.

AIM

• To examine the radioactivity distribution in tumor and targeted tissues and to determine how it relates to treatment outcomes in TARE for HCC.

HYPOTHESIS

• The dose distribution of the radioactivity relative to the tumor bed will correlate with treatment outcomes.

METHODS

• 26 patients (21 males and 5 females with a median age of 62), who received TARE with both glass (14) and resin (12) Yttrium 90 microspheres for HCC were analysed retrospectively.

• Dose volume histograms (DVH) were generated along with mean dose delivered to both tumor and targeted segment(s)/lobe using MIM software's Y90 Sureplan.

• The mean delivered dose to tumor and targeted liver segment(s)/lobe were compared for all patients along with tumor size and tumor percentage of target area.

• Treatment responses were evaluated using the modified Response Evaluation Criteria in Solid Tumors (mRECIST) guideline on an average of 2.5 months post-treatment imaging.

• Resin and Glass microspheres were compared.

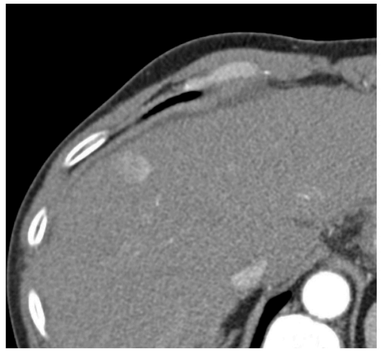

Figure 1: Pre-transarterial radioembolization (TARE) treatment contrast-enhanced CT showing arterial phase enhancement of hepatocellular carcinoma (HCC) lesion in segment 8 of the liver. This lesion also demonstrated portal venous phase washout that is not pictured.

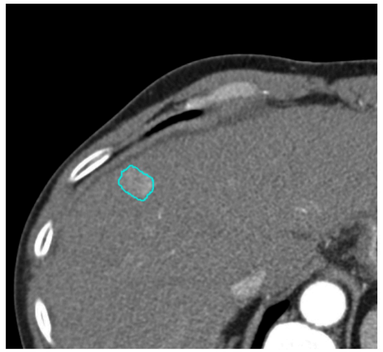

Figure 2: Pre-treatment CE CT from **Fig. 1** now with arterial enhancing HCC lesion contoured (cyan).

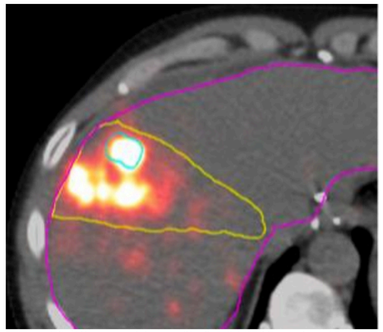

Figure 3: Post-TARE treatment Y90 PET/CT fusion with overlay of fused pre-treatment contours from **Fig. 2** demonstrating radioactivity within the targeted segment 8 (yellow contour) of the liver (magenta contour). Uneven radioactivity distribution is seen with a preference for the hypervascular tumor (cyan contour).

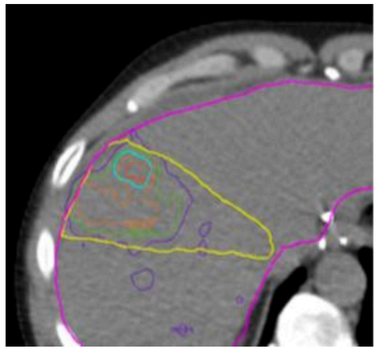

Figure 4: Post-treatment CT from **Fig. 3** with Y90 radioactivity data replaced with isodose lines created using MIM software. Isodose lines indicate 200% (red), 100% (orange), 50% (green), and 25% (blue) of prescription dose (136 Gy).

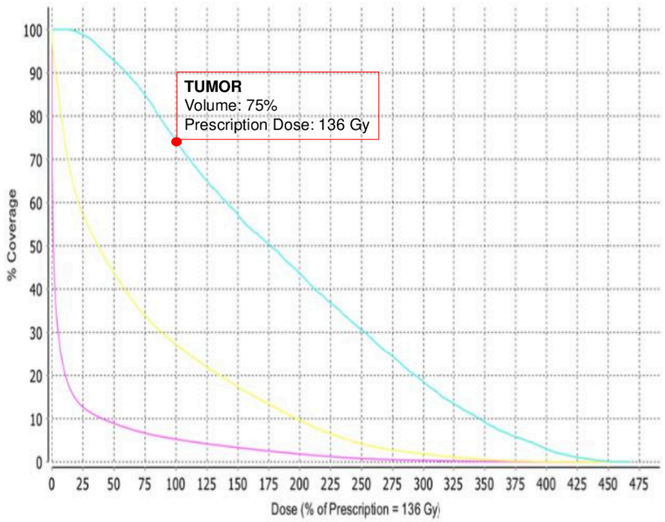

Figure 5: DVH generated by MIM software for the TARE treatment of **Fig. 1-4.** The Prescription Dose is represented by the cyan curve in the tumor, by the yellow curve in the target segment 8, and by the magenta curve in the liver. About 75% of the tumor volume received 100% of the prescription dose (136 Gy), whereas <30% the target segment 8 received 100% of the prescription dose.

RESULTS

• The Mean tumor to target dose ratios were 3.44, 1.82, 1.44, and 1.18 for complete (CR), partial responses (PR), stable (SD) and progressive disease (PD), respectively.

• The average pre-treatment tumor volumes were 23.92, 122.05, 225.15 and 220.80 mL for CR, PR, SD, and PD, respectively.

• The average pre-treatment tumor percentage of target volumes were 5.72%, 17.70%, 20.2% and 23.25% for CR, PR, SD, and PD, respectively.

• The mean dose tumor to target ratio was 1.6 and 3.1 for resin and glass microsphere cases, respectively.

• Average pre-treatment tumor volume was 1005.24 and 537.68 mL for resin and glass microsphere cases, respectively.

• The resin microsphere cases had 1 CR, 7 PR, 1 SD, and 3 PD, and the glass microsphere cases had 9 CR, 3 PR, 1 SD, and 1 PD.

CONCLUSIONS

• The mRECIST based treatment responses correlate with the mean tumor to target dose ratio, pre-treatment tumor volume, and pre-treatment tumor percentage of target volume.

• Cases receiving glass microspheres, which had overall better outcomes, had smaller tumors and larger mean tumor to target dose ratios than resin microspheres.

DISCUSSION

• Radioactivity distribution, tumor size, and tumor percentage of target volume are available either the day of treatment or before treatment and may be useful in treatment planning. Further study in this area is needed.

REFERENCES

1. Atassi B, Bangash AK, Bahrani A, et al. Multimodality Imaging Following 90Y Radioembolization: A Comprehensive Review and Pictorial Essay. *RadioGraphics*. 2008;28(1):81-99.
2. Nelson A, Swallen A, Arpidone M, Nelson D. Dosimetry for Yttrium-90 Microsphere Brachytherapy. *MIM Software Inc.*

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