



Comparison of Dosimetry Models to Predict Outcome for Radioembolization in Patients with Intermediate to Advanced Hepatocellular Carcinoma

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Background and Aim

- **Yttrium-90 (Y90) radioembolization** is an effective locoregional therapy for hepatocellular carcinoma (HCC), which served as an alternative for patients with more extensive tumor burden or vascular invasion in Asian countries.
- No previous study compares the outcome of the **body surface area model (BSA)** and the **partition model (PM)** for resin-based Y-90 particles.
- We aim to compare two dosimetry models in BCLC B to C patients and determine whether there is an optimal tumor dose to predict better outcomes.

Dosimetry methods for resin-based Y90 particles

BSA model

- Activity [GBq] = $(BSA - 0.2) + \left(\frac{\text{tumor volume}}{\text{total liver volume}} \right)$

BSA, Body surface area

Partition model

- Activity [GBq] = $\frac{D[Gy] \times \left(\frac{T}{N} \times M_{\text{tumor}}[kg] + M_{\text{normal}}[kg] \right)}{50[J/GBq] \times (1 - \text{lung shunt})}$

D, Estimated dose
M, Mass

- T/N ratio** = $\frac{A_{\text{tumor}}/M_{\text{tumor}}}{A_{\text{normal liver}}/M_{\text{normal liver}}}$ (from Tc-MAA image)

Methods

- Retrospective cohort study in a single tertiary medical center in Taiwan, between May 2016 to September 2019
- 89 patients with **intermediate to advanced HCCs** are eligible
- Analysis
 - Kaplan-Meier analysis for overall survival (OS)
 - Clinical data, laboratory profiles and dosimetry parameters were collected.
 - The dosimetry parameters of the BSA group were retrospectively calculated.
 - Univariate and multivariable analysis for prognostic factors of OS were performed using Cox proportional-hazards model.

Patient enrollment

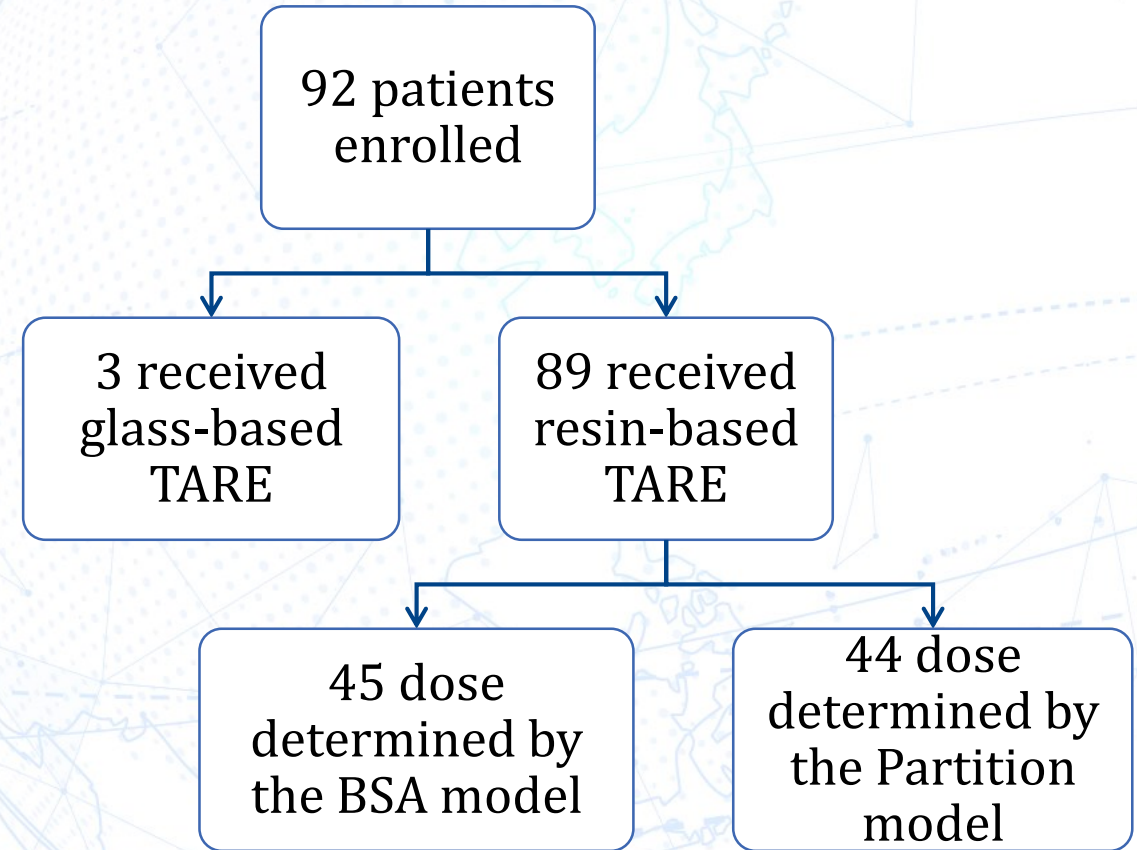
Inclusion criteria

- BCLC stage B & C
- Child-pugh A-B
- Post TACE/TAE >3 months interval

Exclusion criteria

- Bil > 1.5X ULN
- Hepatopulmonary shunt leading to a lung dose > 30Gy
- Previous external beam radiotherapy
- Tumor burden > 50% of liver

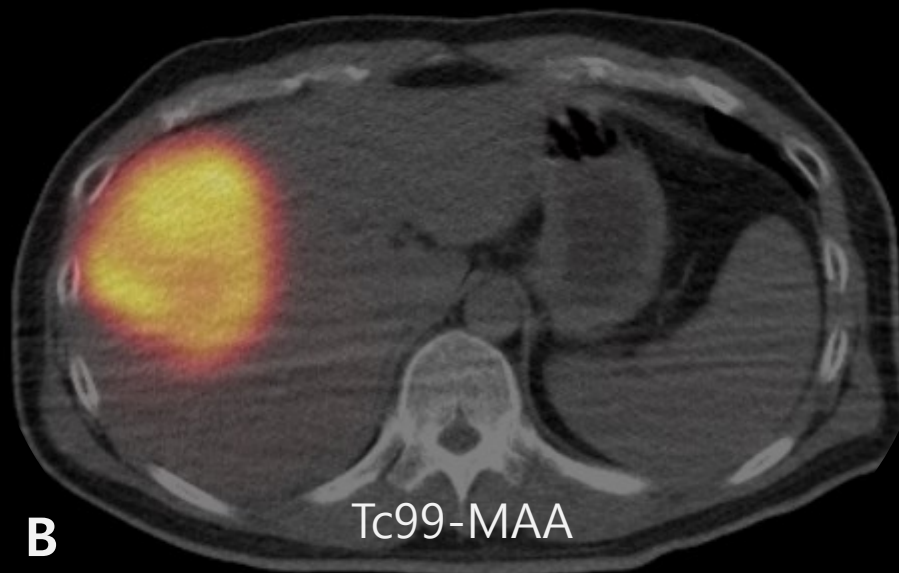
TARE, transarterial radioembolization





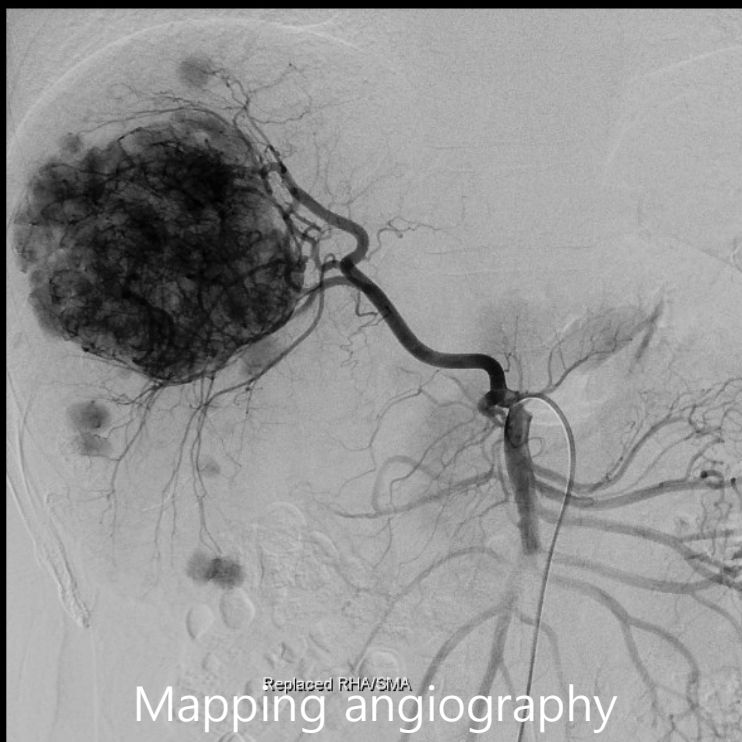
Pre-treatment MRI

A



Tc99-MAA

B



Mapping angiography

C

D

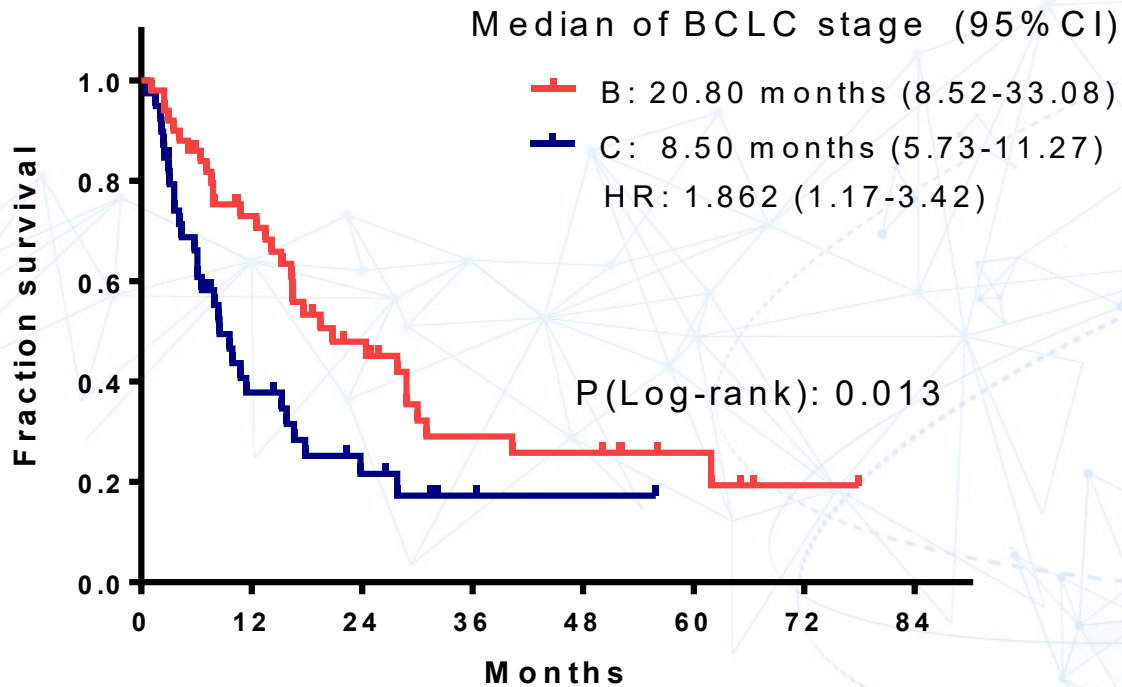


Post-TARE CT at 4th month

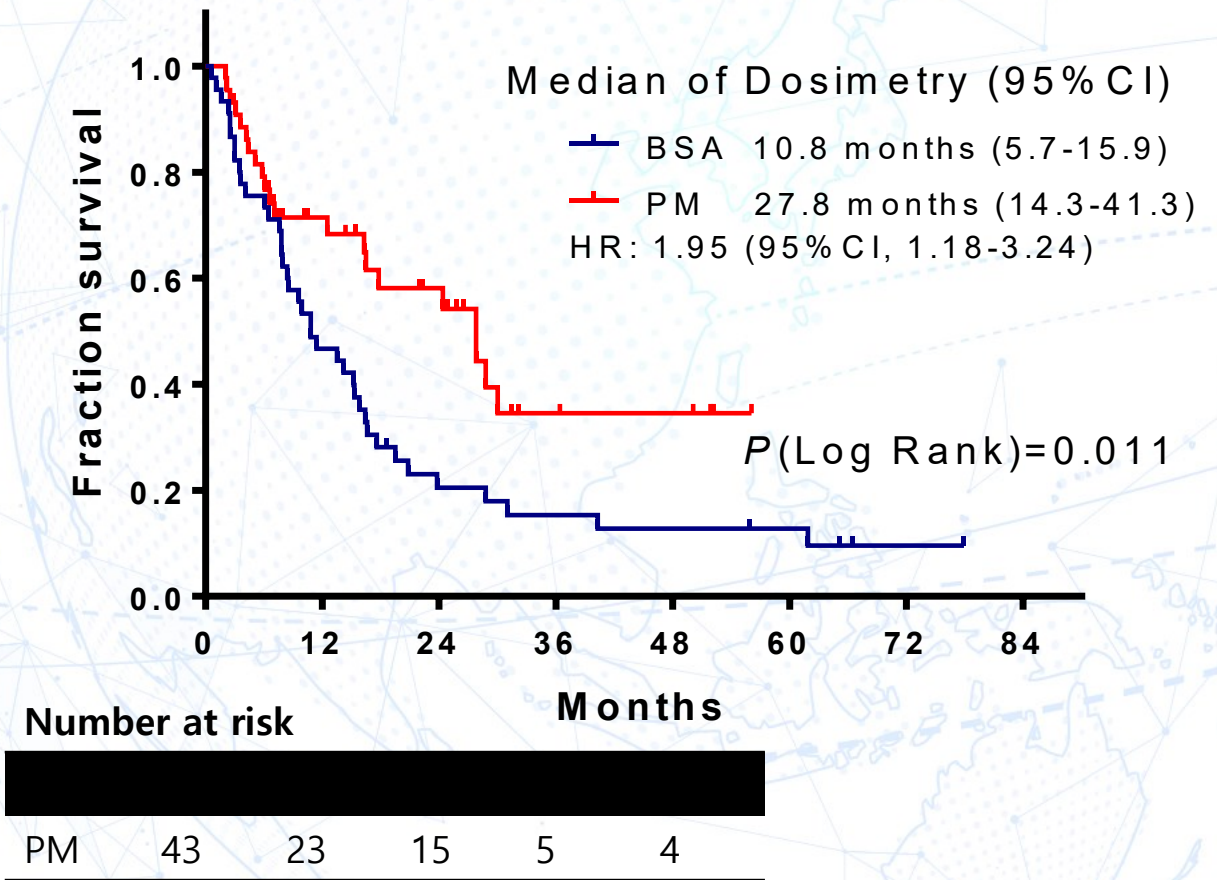
Figure 1. A serial images of one patient underwent Y90-radioembolization with dose determined by the partition method. (A) The staging MRI shows a 9.2cm hepatocellular carcinoma in S5-8 with initial stage cT3N0M0. (B) Tc-MAA image obtained before Y90-TARE to predict dose distribution and lung shunt. (C) Radioembolization with 1.4GBq Y-90 microsphere (SIR-sphere) delivered in right hepatic artery. The estimated tumor dose was 150.34Gy; normal liver dose was 14.95Gy. (D) On the 4-month follow-up, CT shows significant shrinkage of the HCC (5.5cm) in S5-8.

Comparison of OS Stratified by BCLC stage and dosimetry models

Overall Survival

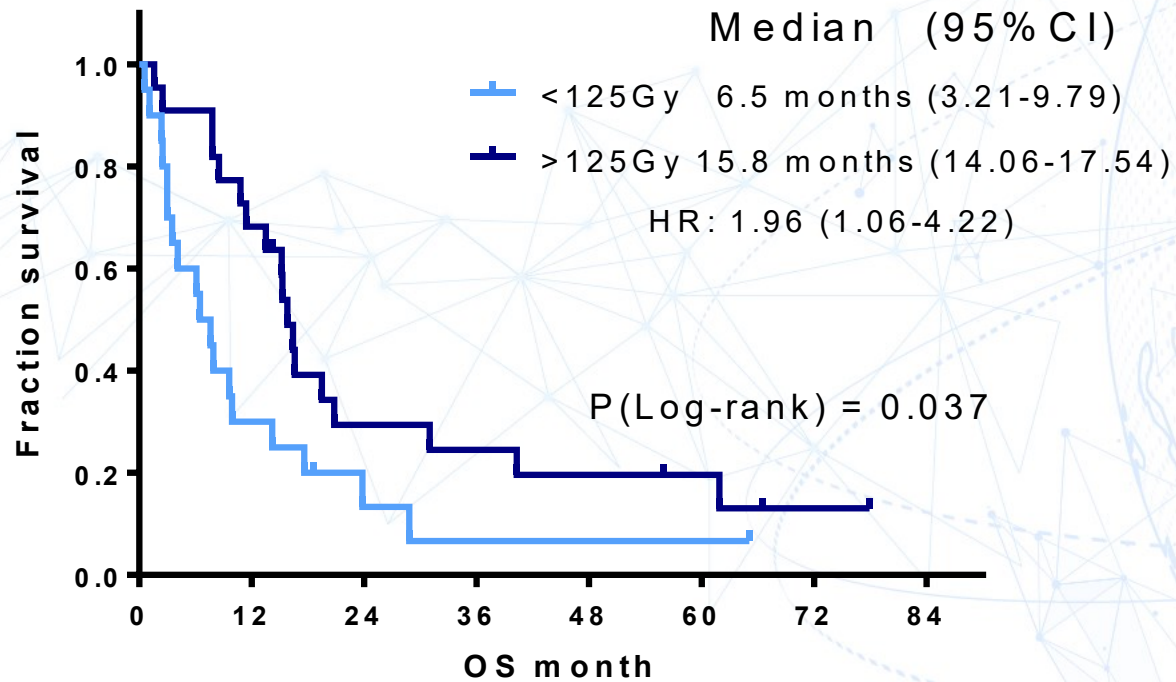


Overall survival

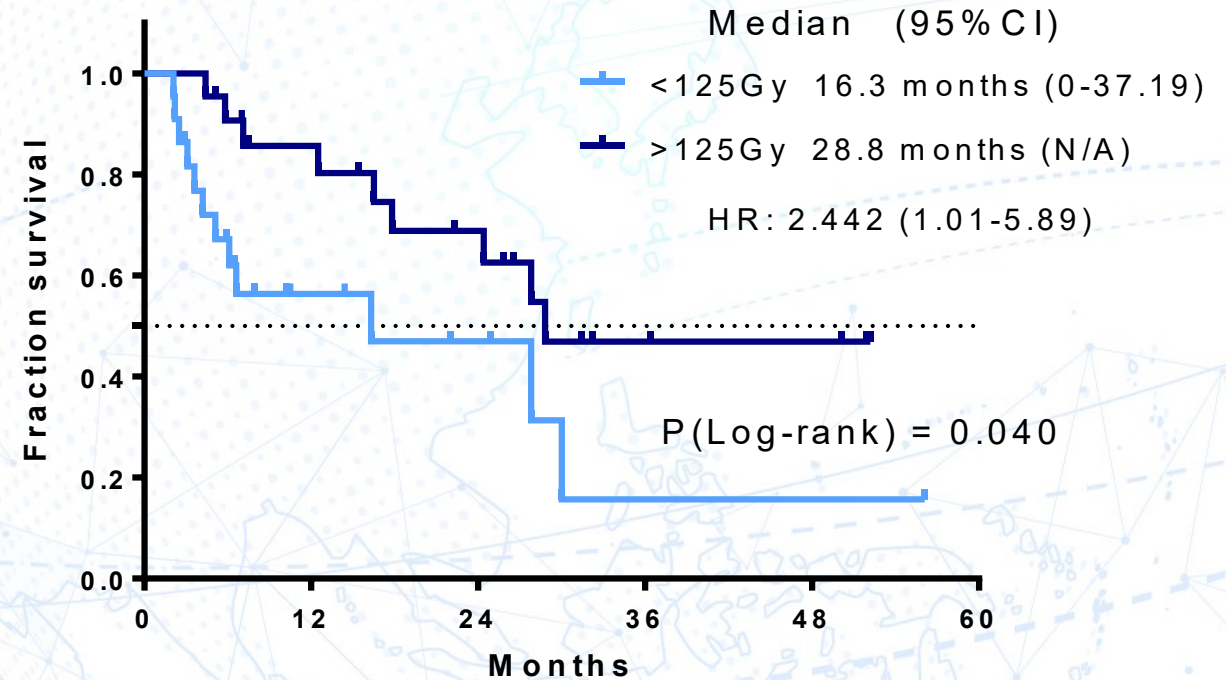


Subgroup Comparison of OS Stratified by Tumor Dose

Overall Survival (BSA group)



Overall Survival (PM group)



Univariate and multivariable analysis (Cox proportional-hazards of OS)

Characteristics	Univariate			Multivariable		
	P-value	HR	95%CI	P-value	HR	95%CI
Age	0.469	1.01	0.984-1.036			
Sex M vs F	0.073	1.983	0.938-4.190			
BCLC C vs B	0.015*	1.899	1.134-3.182	0.286	1.422	0.744-2.724
AFP Level (>400)	0.001*	2.515	1.494-4.235	0.107	1.756	0.886-3.481
Child B vs A	0.019*	3.099	1.201-7.994	0.238	1.953	1.705-5.917
Unilobar vs Bilobar	0.067	0.617	0.368-1.034			
Dosimetry (PM vs BSA)	0.013*	0.507	0.297-0.865	0.012*	0.491	0.282-0.854
TN ratio	0.239	1.037	0.976-1.102			
Tumor Dose (>125)	0.005*	0.467	0.275-0.793	0.019*	0.514	0.294-0.898
Post-Y90 Curative Tx	0.001*	0.291	0.145-0.587	0.066	0.483	0.222-1.050

Conclusion

- Multivariable analysis demonstrated that dosimetry method and tumor dose ($>125\text{Gy}$) are significant independent prognostic factors.
- Y-90 radioembolization with **partition model** and **tumor dose over 125Gy** improved OS in patients with intermediate to advanced HCCs.
- Limitation
 - This is a retrospective, single medical center study. The tumor dose of the BSA group was derived indirectly by re-accessing the previous images, discrepancy may present from practical condition.