Radiation Pneumonitis in Y90 Radioembolization

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Purpose

- Radiation pneumonitis (RP) is a rare but serious complication of Yttrium-90 (Y-90) radioembolization.
- The current guideline recommends a maximum lifetime lung dose of 30 Gy per treatment and 50 Gy in a lifetime, which is an expert opinion (Level 5 evidence) established based on limited evidence.
- The purpose of this educational exhibit is to review the need for updated guideline with an aim to personalize a patient's lung dose limit based on their treatment plans as well as their lung health and characteristics.

Methods

- We present an evaluation of a systemic review that identified 48 RP cases after Y-90, classifying based on microsphere type, hepatopulmonary shunt fraction, and estimated lung dose.
- We also reviewed studies addressing limitations in lung dose estimation, including how to more accurately estimate patient-specific dosimetry, predicting microsphere distribution, and correcting vendor-related biases in calculating lung mean dose.

Figure 1: Adapted from *Kis et al.* CT image of post-Y90 radiation pneumonitis.

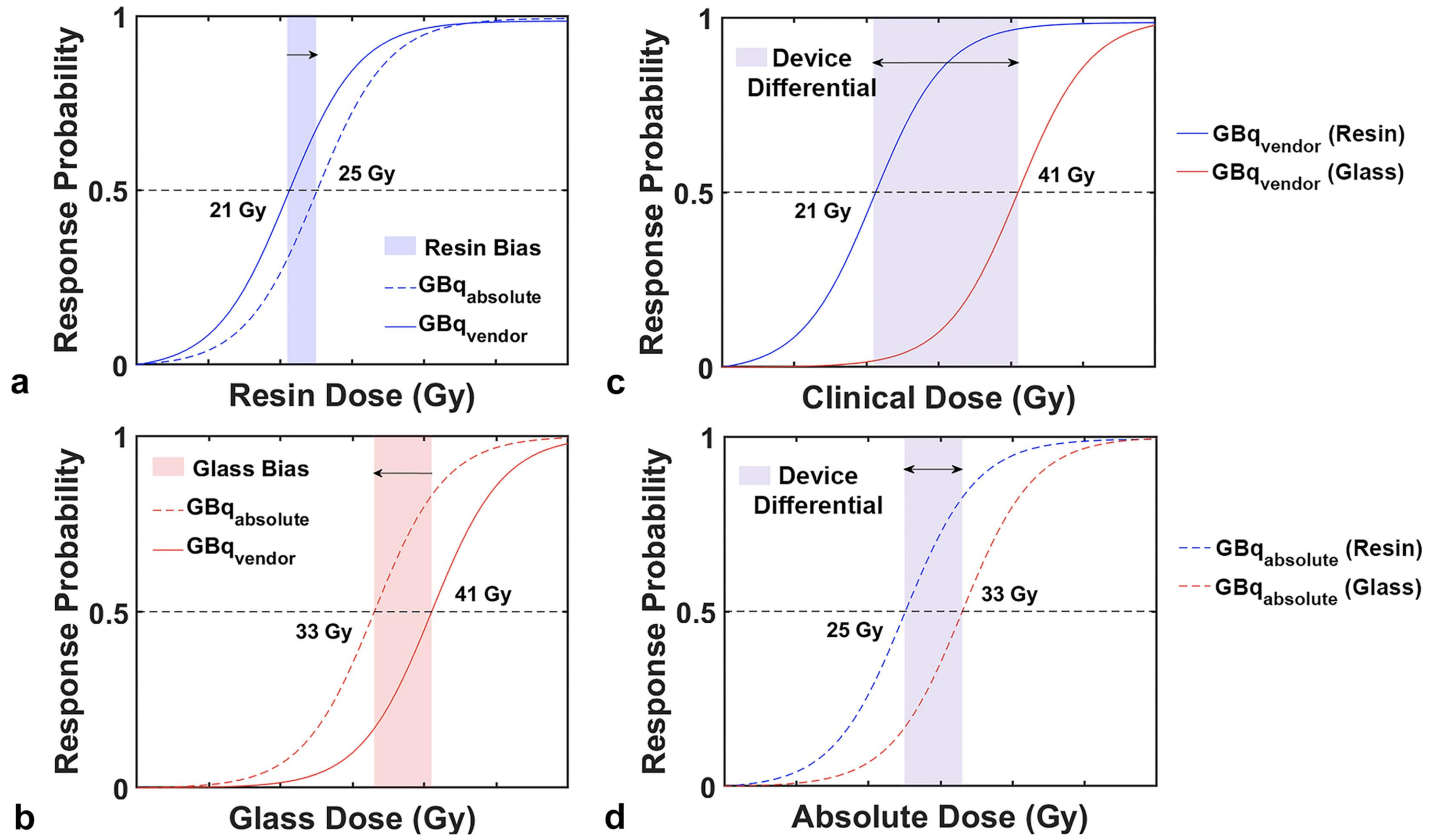

Figure 2: Adapted from *Thomas et al.* Simulated dose-response curves for radiation pneumonitis in yttrium-90 radioembolization. Differences between dose-response curves due to biases in GBqvendor showed that (a) clinical resin doses were underestimated by ~4 Gy, whereas (b) glass doses were overestimated by ~8 Gy. (c) The overall differential between the 2 devices using clinical doses was ~20 Gy. (d) After correction for biases in both devices, the absolute dose differential was only ~8 Gy. GBqabsolute = absolute activity; GBqvendor = vendor-stated activity.

Results

- Review of recent literature highlights significant uncertainties in predicting and preventing RP following Y-90 radioembolization.
- Current lung dose limits (30 Gy/session, 50 Gy lifetime) are based on outdated external-beam data and may not reflect true toxicity risk.
- Planar scintigraphy frequently overestimates lung shunt fraction, whereas SPECT/CT improves patient-specific dose calculations.
- Safe lung dose thresholds may be lower than traditionally cited—approximately 15 Gy for resin and 25–30 Gy for glass microspheres.
- Vendor-reported activity introduces systematic biases in lung mean dose (LMD) estimates, with resin doses underestimated by ~4 Gy and glass doses overestimated by ~8 Gy. After correcting for these biases, the difference in lung dose thresholds between microsphere types is smaller than previously reported.

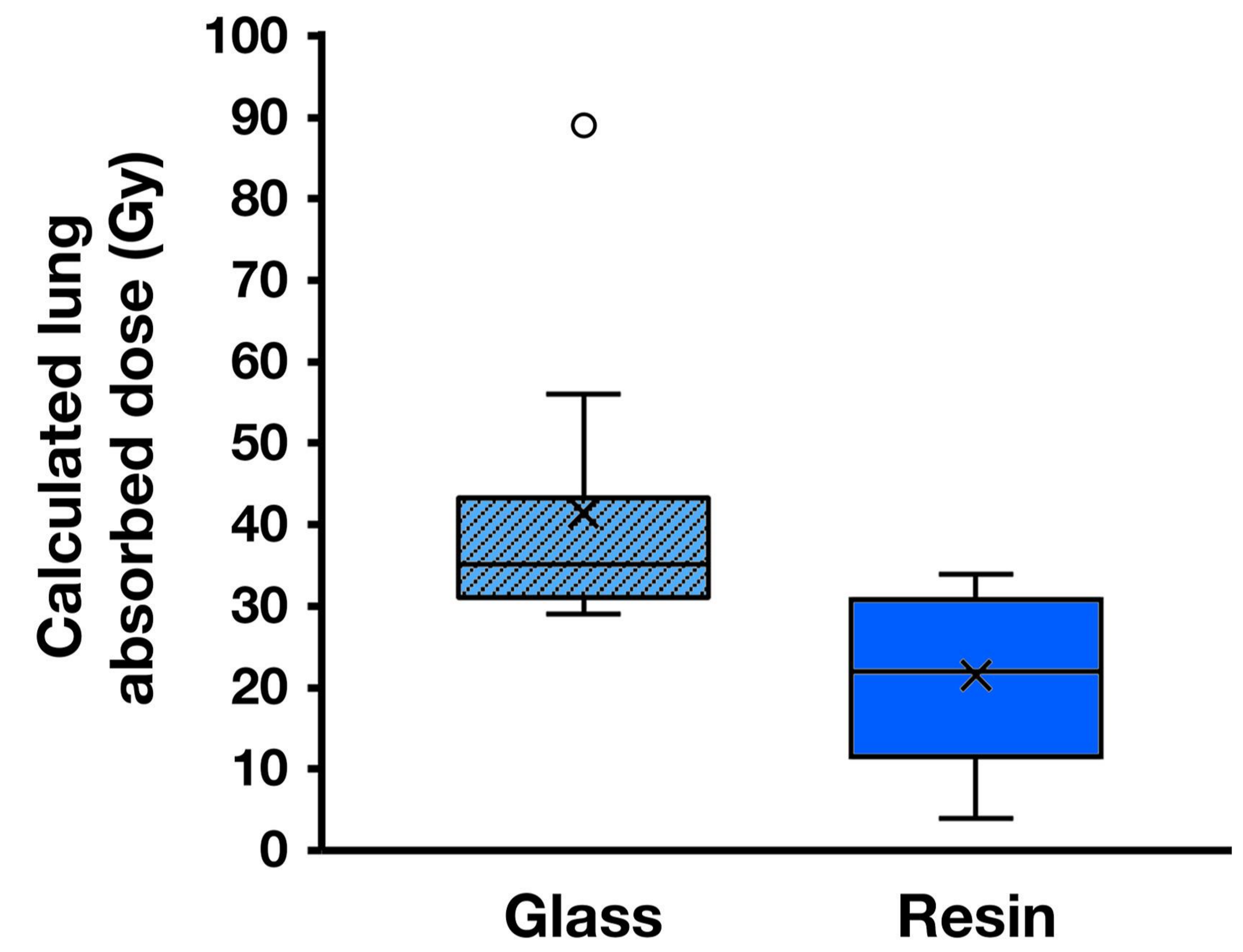

Figure 3: Adapted from *Kis et al*. Estimated lung absorbed doses in patients with radiation pneumonitis who were treated with glass or resin yttrium-90 microspheres**.**

Conclusion

- With a rapid increase in use of Y-90 radioembolization by IR, it is imperative that physicians understand the clinical and technical factors that can predispose patients to RP.
- Recent studies highlighted the limitations associated with the current guideline for lung dose limits to prevent RP and highlight the need for personalized dosimetry approaches, improved pre-treatment microsphere distribution prediction, and bias-corrected lung dose estimation to more accurately assess RP risk.

References

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