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A Peek into the Reported Radiation Exposures Discrepancies during Y90 Procedures In the IR Suite

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ABSTRACT

Purpose: Y90 radioembolization often requires both fluoroscopy and CBCT to guide the complex treatment procedure. However, radiation data in the form of RDSRs and Dose Sheets are usually combined across these imaging modalities, making it harder to understand their unique dose contributions. This study quantitatively compares dose contributions from fluoroscopy and CBCT across a large cohort of Y90 cases to improve characterization of radiation exposure and support effective reporting practices in the dose sheets.

Methods: Radiation Structured Dose Report and Dose Sheet data from all Y90 procedures over 15 years at a single academic institution were extracted (n = 459 patients, 54,866 radiation events). Patient demographics and procedure-specific radiation metrics were analyzed to identify reporting discrepancies across physicians and modalities.

Results: Significant discrepancies in numbers of recorded events and radiation dose contributed were noted as CBCT comprised only 2.8% of all recorded radiation events yet accounted for 44.2% of the total radiation dose. Furthermore, fluoroscopy comprised 97.2% of events and 55.8% of the total radiation dose. The number of recorded events per procedure on average were 3.3±2.6 acquisitions per procedure for CBCT and 116.2±80.6 acquisitions per procedure for fluoroscopy. Although the mean cumulative dose per procedure was greater for fluoroscopy (928.7±895.8 mGy) than for CBCT (735.4 ± 626.1 mGy), the per-acquisition dose was dramatically higher for CBCT (222.4±50.7 mGy vs 8.0±41.7, $p < 0.0001$). CBCT events demonstrated significantly higher DAP (68.5 ± 15.8 Gy·cm²) and larger collimated fields (1,096.7±37.6 cm²) than fluoroscopy (both $p<0.0001$). The high per-entry radiation intensity of CBCT underscores the need for separate, modality-specific reporting to improve accuracy in assessing patient exposure.

Conclusion: This study reveals significant discrepancies in radiation dose reporting between CBCT and fluoroscopy procedures during Y90 radioembolization procedures.

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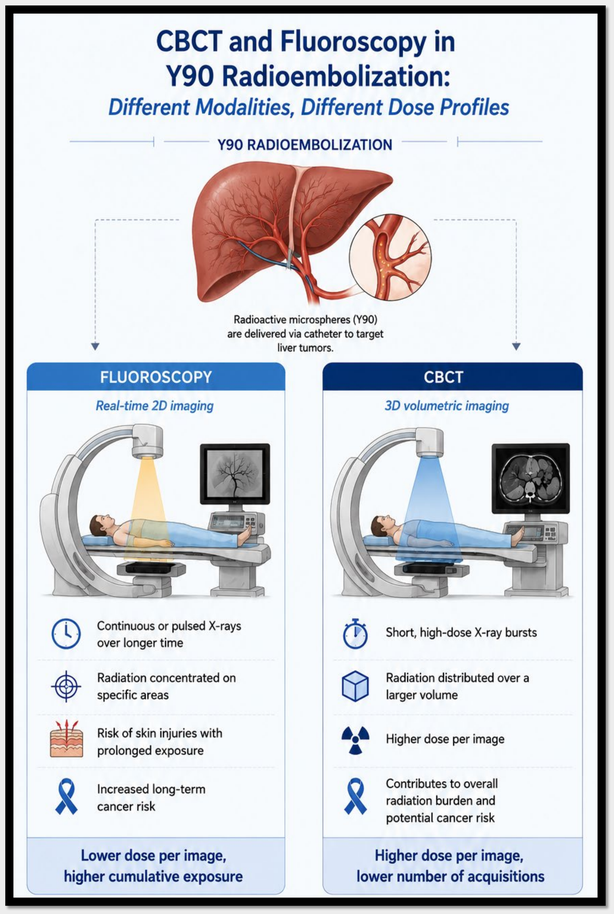
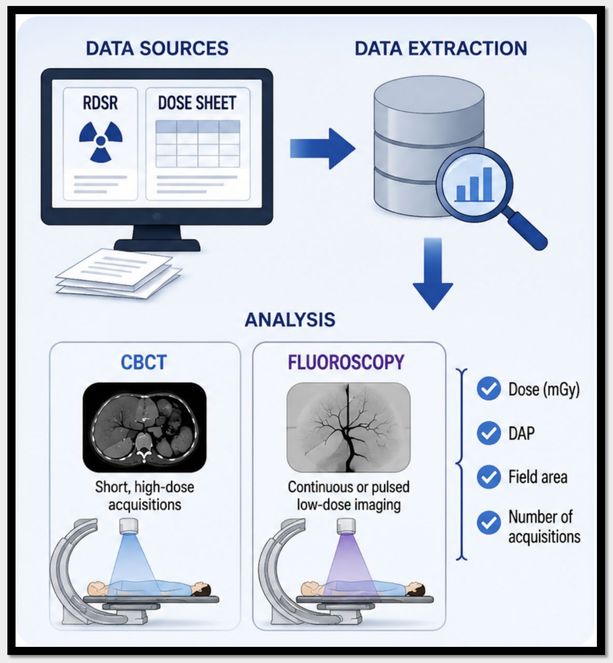
INTRODUCTION

- Yttrium-90 (Y90) radioembolization is a minimally invasive treatment for primary and metastatic liver cancers that delivers radioactive microspheres directly to liver tumors.
- Cone beam computed tomography (CBCT) and fluoroscopy are routinely used for imaging guidance during Y90 radioembolization procedures.
- CBCT and fluoroscopy have distinct radiation exposure profiles. Fluoroscopy uses continuous or pulsed X-rays for real-time imaging, whereas CBCT acquires high-resolution 3D images using short, higher-dose exposures.
- Differences in exposure duration, dose distribution, and imaging technique may result in different biological effects and radiation risks for patients.
- Current radiation dose reports often combine CBCT and fluoroscopy doses into a single cumulative value, potentially obscuring the contribution and risk profile of each imaging modality.
- More accurate characterization of radiation exposure may improve patient safety, radiation monitoring, and dose optimization during interventional procedures.



MATERIALS & METHODS

- Retrospective review of Y90 radioembolization procedures performed over 15 consecutive years (2010-2025) at a single academic medical center.
- Radiation Structured Dose Reports (RDSR) and Dose Sheets were analyzed.
- Study cohort: 459 patients (54,866 radiation events).
- Extracted variables included radiation dose (mGy), dose-area product (DAP), collimated field area, and acquisition frequency.
- Radiation metrics were compared between CBCT and fluoroscopy using statistical analysis.



RESULTS

- A total of 459 patients undergoing Y90 radioembolization were analyzed, representing 54,866 radiation events over a 15-year period.
- CBCT accounted for only 2.8% of all radiation events (1,518 events), whereas fluoroscopy accounted for 97.2% (53,348 events).
- Despite its low frequency, CBCT contributed 44.2% of the total radiation dose, compared with 55.8% from fluoroscopy.
- The mean number of imaging acquisitions per procedure was 3.3 ± 2.6 for CBCT and 116.2 ± 80.6 for fluoroscopy.
- Average total radiation dose per procedure was 735.4 ± 626.1 mGy for CBCT and 928.7 ± 895.8 mGy for fluoroscopy.
- Radiation dose intensity per imaging event was significantly higher for CBCT than fluoroscopy:
  - CBCT: 222.36 ± 50.68 mGy/event
  - Fluoroscopy: 7.99 ± 41.70 mGy/event
  - $p < 0.0001$

RESULTS (cont..)

- Dose-area product (DAP): 68.50 ± 15.82 vs. 1.58 ± 9.26 ($p < 0.0001$)
- Collimated field area: 1096.71 ± 37.57 vs. 445.79 ± 339.52 ($p < 0.0001$)

	CBCT	Fluoro	p-value
Total events	1518	53348	-
Mean number of events per procedure	3.3 ± 2.6	116.2 ± 80.6	-
Proportion of total dose (mGy)	44.2%	55.8%	-
Mean total dose per procedure (mGy)	735.4 ± 626.1	928.7 ± 895.8	-
Mean Dose	222.36 ± 50.68	7.99 ± 41.70	<0.0001*
Mean DAP	68.50 ± 15.82	1.58 ± 9.26	<0.0001*
Mean Collimated Field Area	1096.71 ± 37.57	445.79 ± 339.52	<0.0001*
Mean Primary Angle	-79.40 ± 56.23	-9.31 ± 69.20	<0.0001*
Mean Number of Pulses	393.80 ± 26.29	21.61 ± 34.78	<0.0001*
Mean kVp	107.36 ± 8.38	-3180.12 ± 83618.73	1.0000
Mean mA	555.57 ± 58.33	-3072.73 ± 83623.00	0.8185
Mean mAs	1006.17 ± 156.02	-3161.12 ± 83620.19	0.4696
Mean Source to Detector Distance	1197.88 ± 0.36	1099.61 ± 77.25	<0.0001*

CONCLUSIONS

- Significant discrepancies exist between CBCT and fluoroscopy radiation dose contributions during Y90 radioembolization procedures.
- Although CBCT accounted for only 2.8% of imaging events, it contributed 44.2% of the total radiation dose.
- CBCT delivered substantially higher radiation intensity per acquisition than fluoroscopy (222.36 ± 50.68 vs. 7.99 ± 41.70 mGy/event; $p < 0.0001$).
- Combined reporting of CBCT and fluoroscopy may obscure modality-specific radiation contributions and associated risk profiles like peak skin dose calculations.
- Separate reporting of CBCT and fluoroscopy doses could improve radiation exposure assessment, support dose optimization, and enhance patient safety.

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