

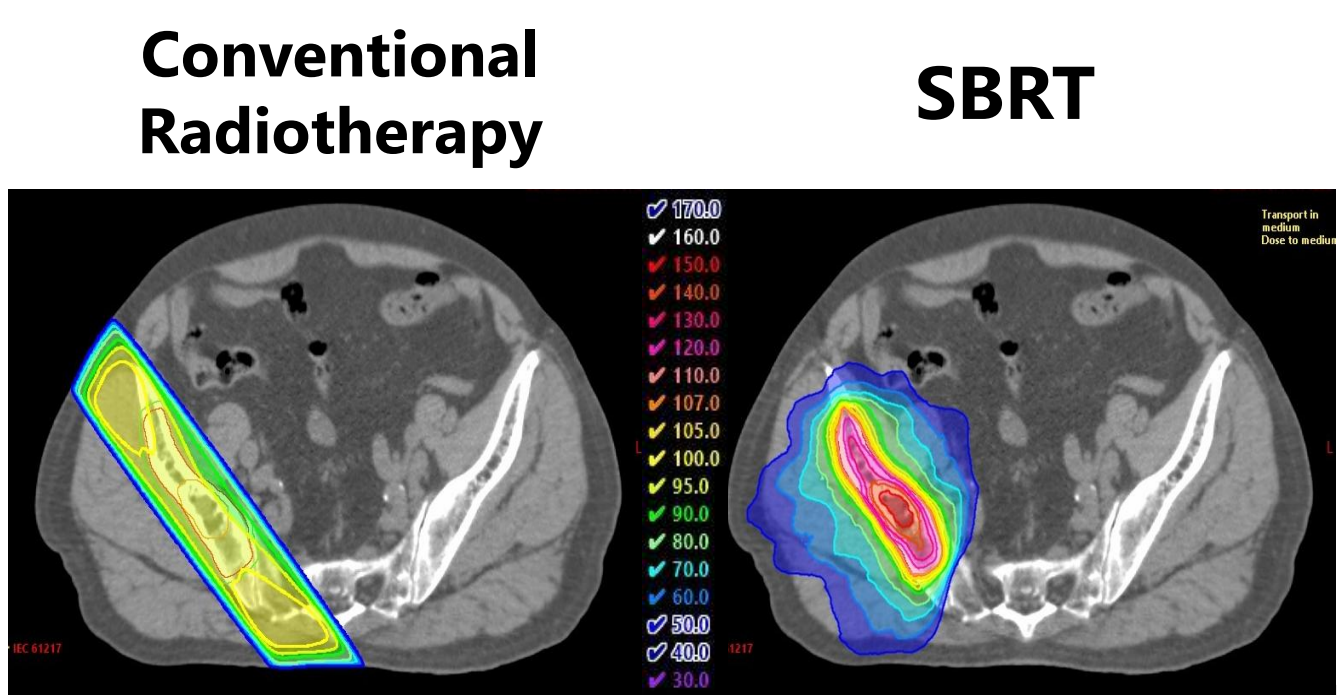
Radiomics- and Dosimetrics-Based Machine Learning Models for Predicting 1- and 2-Year Local Failure After SBRT for Non-Spinal Bone Metastases

Sato Takahashi^{1, 2}, Yujiro Nakajima^{1, 2}, Syoma Ide^{1, 2}, Kei Ito², Tomohiro Kajikawa³, Fumiya Tsurumaki², Kentaro Taguchi², Yuhi Suda², Satoshi Kito², Yukio Fujita¹, Keiko Murofushi², Naoki Tohyama¹

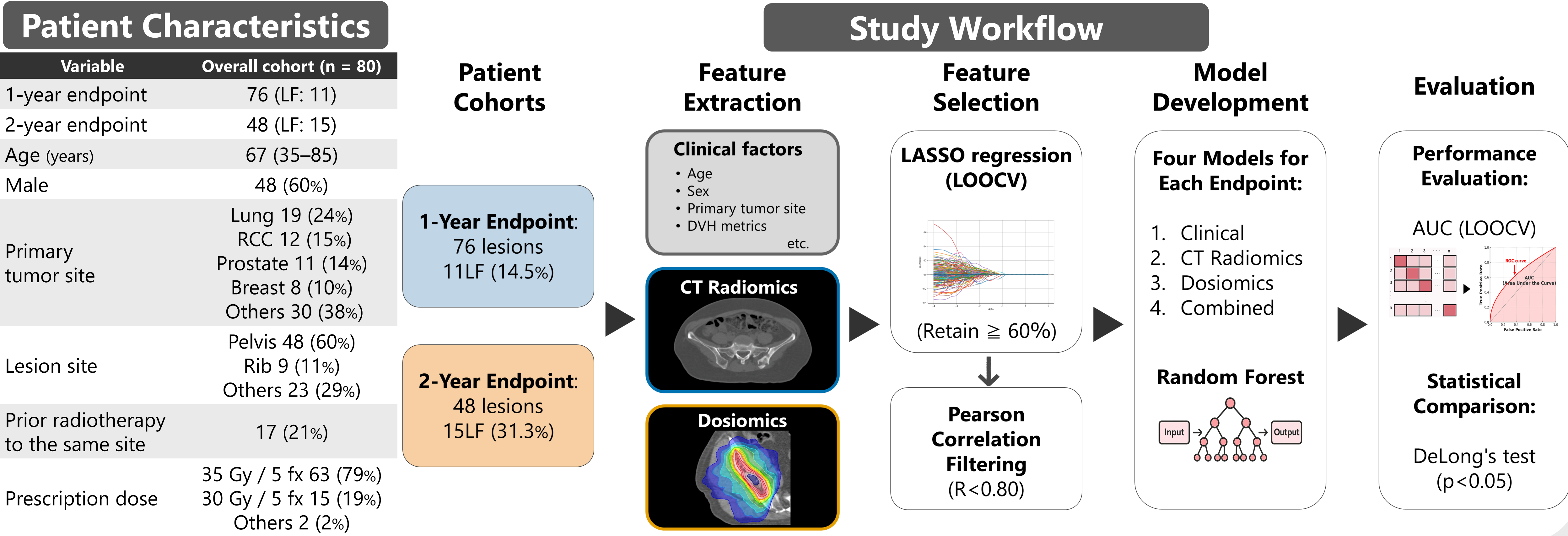
1 Komazawa University Graduate School | 2 Tokyo Metropolitan Cancer and Infectious Diseases Center Komagome Hospital | 3 Kyoto Prefectural University of Medicine

1. INTRODUCTION

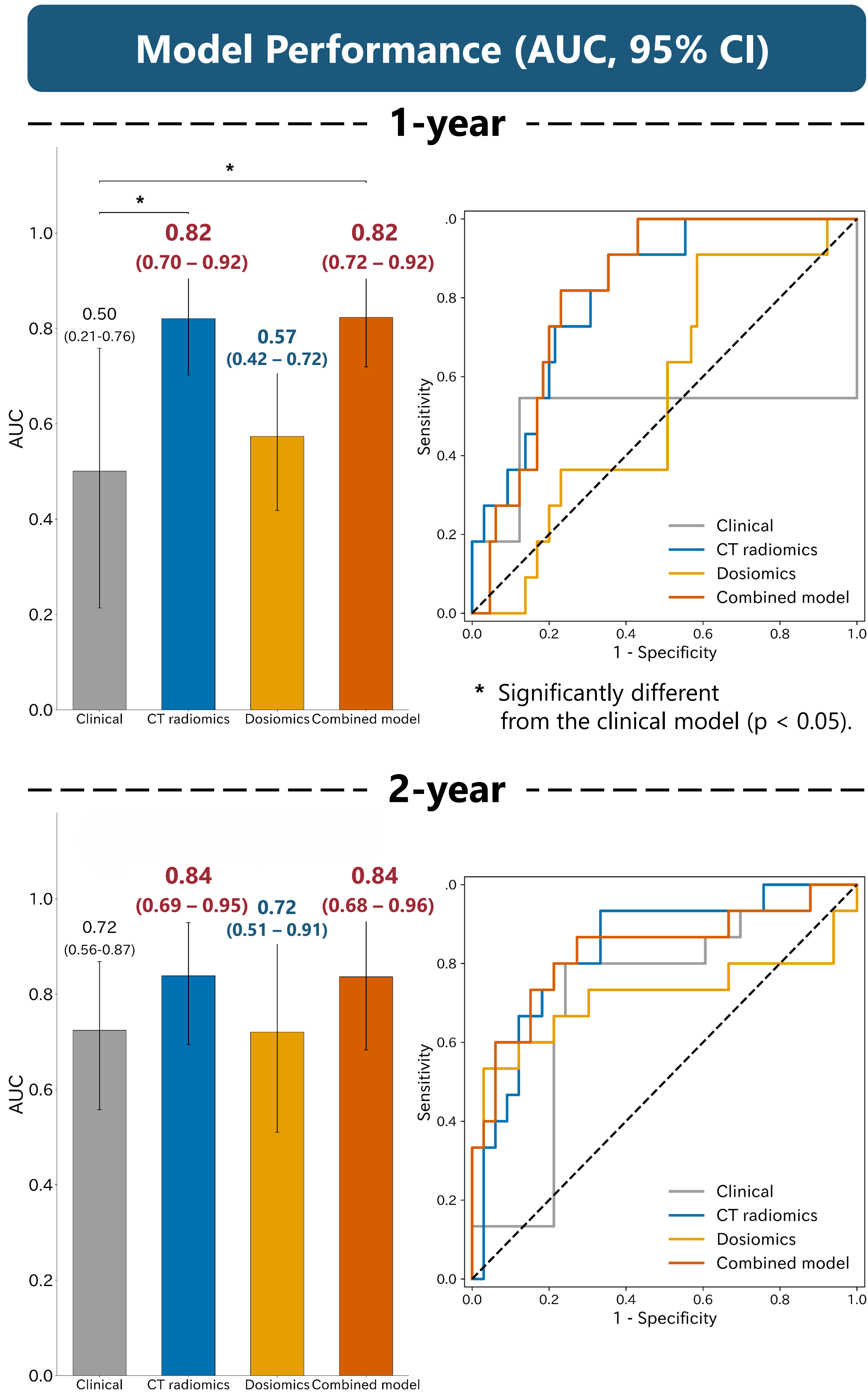
- Background**
Compared with conventional radiotherapy, **stereotactic body radiotherapy (SBRT)** may improve local control for **non-spinal bone metastases (NSBM)**¹.
- Problem**
Approximately **10%** of patients develop **local failure (LF)** after SBRT², and **reliable predictive biomarkers remain unavailable**.
- Purpose**
To develop radiomics- and dosimetrics-based machine learning models for predicting LF after SBRT for NSBM.



2. MATERIALS AND METHODS



3. RESULTS



Selected Features and Multivariable Analysis for the Combined Model

Modality		Features	Multivariable	
			OR (95%CI)	P-value
1-year	Clinical	Primary tumor site: Esophagus	14.8 (NE)	1.0
		Primary tumor site: Cervical	44.1 (NE)	1.0
	CT radiomics	Skewness (HHH)	0.36 (0.16–0.82)	< 0.05
		Cluster Shade (HLH)	5.71 (0.58–55.9)	0.13
	Dosimomics	Median (LLH)	0.58 (0.29–1.17)	0.13
Gray Level Nonuniformity (LHL)		3.28 (0.86–12.4)	0.08	
2-year	CT radiomics	Kurtosis (HHL)	1.72 (0.31–9.60)	0.53
		Kurtosis (LHH)	1.37 (0.34–5.47)	0.66
		Skewness (HHH)	0.46 (0.16–1.30)	0.14
		Sum Squares (LHL)	3.62 (0.76–17.1)	0.11
	Dosimomics	Small Dependence Low Gray Level Emphasis (HHL)	0.62 (0.17–2.22)	0.46
		Size Zone Nonuniformity Normalized (original)	2.27 (0.57–9.03)	0.24
		Low Gray Level Zone Emphasis (LHH)	0.39 (0.11–1.38)	0.14

OR, odds ratio; CI, confidence interval; NE, not estimable. P-values represent the results of multivariable logistic regression analyses evaluating the association between the selected features and 1- or 2-year LF after SBRT.

- CT radiomic features provided the most informative predictors of LF.**
- Combined models showed no substantial improvement over CT radiomics alone.
- Dosimetric features contributed limited additional information in this cohort.**
- Selected radiomic features were predominantly related to **image intensity heterogeneity and texture patterns**.

4. DISCUSSION

- Tumor Heterogeneity Captured by Radiomics**
CT radiomics demonstrated **the highest predictive performance** for both endpoints, suggesting that quantitative image features may capture tumor heterogeneity associated with LF more effectively than conventional clinical factors.
- Biological Interpretation of Selected Features**
Several selected CT radiomic features, including skewness, kurtosis, and texture-based features, reflect intensity heterogeneity and spatial complexity within the tumor. These findings suggest that **intratumoral heterogeneity** may contribute to LF after SBRT.
- Limited Contribution of Dosimetrics**
In contrast, dosimetrics showed **limited predictive performance**. One possible explanation is that LF after SBRT may be influenced more strongly by intrinsic tumor characteristics than by dose distribution patterns. In addition, dosimetric features were extracted only within the PTV, where dose heterogeneity may have been relatively limited.

5. CONCLUSIONS

- CT-derived radiomic features showed predictive value for local failure after SBRT for NSBM.
- Radiomics-based models may facilitate early risk stratification and support personalized post-treatment management.

6. REFERENCES

- Nguyen TK, et al. Stereotactic body radiotherapy for non-spine bone metastases: A meta-analysis and ISRS clinical practice guidelines. Radiother Oncol. 2025;205:110717.
- De la Pinta C, et al. Stereotactic body radiation therapy for non-spine bone metastases: a literature review. Radiat Oncol. 2020;15:295.