



P1.095: A GAN-Based Multimodal Model for Preoperative Prediction of High-Risk Components and Lymph Node Metastasis in Early-Stage Lung Adenocarcinoma

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INTRODUCTION

Early-Stage Lung Adenocarcinoma (LUAD)
Management: The increasing detection of small ($\leq 3\text{cm}$) LUAD via low-dose CT highlights the critical need for precise surgical planning, balancing lung-preserving sublobar resection with oncological efficacy.
Limitations of Traditional Imaging: Conventional CT assessment struggles to accurately quantify the intra-tumoral high-risk Components concentration ratio (HCCR) and predict lymph node metastasis (LNM), often resulting in overtreatment or undertreatment.
The Power of Multimodal AI and GANs: Integrating radiomics, clinical, and pathological data using Generative Adversarial Networks (GANs) offers a powerful approach to extract deep, cross-modal features that capture complex tumor heterogeneity.
OBJECTIVE: To develop and validate a GAN-based multimodal predictive model that precisely quantifies HCCR and predicts LNM in early-stage LUAD, providing a robust decision-support tool to optimize personalized surgical strategies.

METHODS

Study Design:
A retrospective study of 2,067 early-stage LUAD patients across **5 centers**. We designed **a multimodal framework** integrating clinical, pathological, and CT/PET radiomics data. A conditional GAN (cGAN) drove CT-to-PET synthesis and deep feature fusion, powering two independent modules to **predict HCCR and LNM**.
The model's predictive performance and clinical utility were then rigorously evaluated against conventional single-modality models using area under the curve (AUC) and decision curve analysis (DCA).

DISCUSSION AND CONCLUSION

Actionable Take-Home Message

- Clinical Decision Support:** This study establishes a highly accurate GAN-based multimodal model that successfully predicts the high-risk Components concentration ratio (HCCR) and lymph node metastasis (LNM) in early-stage lung adenocarcinoma ($\leq 3\text{cm}$).
- Optimized Surgical Strategy:** Utilizing this model significantly elevates surgical planning accuracy from 75% to 88%, effectively reducing the rates of both overtreatment (unnecessary lobectomies) and undertreatment (inadequate sublobar resections) by approximately 50%.

Future Direction for Research

- Prospective Clinical Validation:** Execute prospective, multicenter randomized controlled trials to confirm the model's real-world clinical utility and long-term impact on patient survival and lung function.
- Expanded Multi-omics Integration:** Incorporate genomics (e.g., EGFR, ALK mutations), proteomics, and liquid biopsy (ctDNA) data to construct a more comprehensive "digital twin" for dynamic risk stratification.
- Explainable AI (XAI) Implementation:** Integrate methods like SHAP or LIME to visualize the GAN's complex feature conversions, enhancing transparency and clinical trust in the model's personalized predictions.

KEY REFERENCE

[1] Duan F, Zhang M, Yang C, et al. Non-invasive Prediction of Lymph Node Metastasis in NSCLC Using Clinical, Radiomics, and Deep Learning Features From 18F-FDG PET/CT Based on Interpretable Machine Learning. Acad Radiol. 2025;32(3):1645-1655.

[2] Altorki NK, Wang X, Kozono D, et al. Lobar or Sublobar Resection for Peripheral Stage IA Non-Small-Cell Lung Cancer. N Engl J Med. 2023;388(6):489-498.

[3] Tian W, Yan Q, Huang X, et al. Predicting occult lymph node metastasis in solid-predominantly invasive lung adenocarcinoma across multiple centers using radiomics-deep learning fusion model. Cancer Imaging. 2024;24(1):8.

[4] Kim PJ, Hwang HS, Choi G, et al. A new model using deep learning to predict recurrence after surgical resection of lung adenocarcinoma. Sci Rep. 2024;14:6366.

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RESULTS

Key Findings

- Superior Predictive Performance:** The GAN-based multimodal model (M-Model) demonstrated exceptional performance on the independent test set, achieving an AUC of 0.85 (95% CI: 0.78–0.92) for predicting HCCR > 5%, and an AUC of 0.82 (95% CI: 0.73–0.91) for predicting LNM .
- Outperforming Traditional Methods:** The M-Model significantly surpassed both the clinical-pathological model (C-P Model, AUCs of 0.72 and 0.68) and the radiomics-only model (R Model, AUCs of 0.78 and 0.75) in predicting HCCR and LNM, respectively.
- GAN's Crucial Role:** Ablation studies confirmed that utilizing GAN for deep feature fusion was critical, yielding a significant AUC improvement (approximately 3-4%) compared to simple feature concatenation.
- Clinical Impact on Decision-Making:** Incorporating the M-Model into clinical workflows increased the accuracy of surgical planning (lobectomy vs. sublobar resection, and lymph node assessment) from 75% (experience-based) to 88%, reducing both overtreatment and undertreatment rates by about 50% .

