



P2.103:Artificial Intelligence Model for Intraoperative Diagnosis of Lung Adenocarcinoma Using Frozen Section Whole-Slide Images

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INTRODUCTION

- Early-stage lung adenocarcinoma is increasingly detected, making accurate intraoperative diagnosis critical for surgical planning.
- Current frozen section has limited accuracy (70–80%) and prolongs surgery time, affecting patient outcomes. There is an urgent need for a fast, precise intraoperative tool to optimize surgical decisions.
- We developed an deep learning model to analyze H&E-stained frozen section whole-slide images (WSIs) for rapid intraoperative diagnosis.

METHODS

- We developed an artificial intelligence system, FS-NET, which is based on Attention-Challenging Multiple Instance Learning (ACMIL) model, to analyze H&E-stained frozen section whole-slide images (WSIs) for rapid intraoperative diagnosis.
- The cohort was divided into training, validation and test sets (6:2:2). Then WSIs were preprocessed to extract tissue patches, and deep features were obtained using a Vision Transformer (ViT-S/16). FS-NET utilized a gated attention mechanism with stochastic top-K instance masking and diversity regularization to aggregate patch-level features into slide-level predictions.
- The model differentiated among pre-invasive lesions (PIL), minimally invasive adenocarcinoma (MIA), and invasive adenocarcinoma (IAC). Performance was evaluated using area under the curve (AUC), sensitivity, specificity and so on.

DISCUSSION AND CONCLUSION

FS-NET provides an accurate, efficient, and interpretable AI-based tool for intraoperative frozen section diagnosis of early lung adenocarcinoma. By offering objective decision support, it assists pathologists in generating more reliable intraoperative reports, enabling thoracic surgeons to better select between lobectomy and sublobar resection.

A prospective, multi-center clinical trial, including Human-AI integration is being planned to further evaluate its clinical utility

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RESULTS

- The study includes **1,900 patients (yielding 2,486 WSI)** with early-stage lung adenocarcinoma from multiple centers. FS-NET achieves an AUC of **0.90** for discriminating IAC from PIL/MIA in internal cohort, while FS-NET achieves an AUC of **0.88** in external cohort 1 and an AUC of **0.76** in external cohort 2.
- Attention heatmaps of FS-NET highlight invasive components, especially in IAC cases, with high-attention regions predominantly localized within invasive foci. This concordance with histopathological characteristics is reinforced by 15 WSIs that were originally classified as PIL during frozen section examination but subsequently diagnosed as IAC on permanent sections. Most attention maps of FS-NET precisely localize the initially overlooked invasive components.
- Overall, FS-NET delivers a precise, rapid, and interpretable artificial intelligence solution for intraoperative frozen section.

