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Build an artificial intelligence prediction model based on deep learning technology to predict the muscular invasion of urothelial carcinoma preoperatively

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Background

Developing an artificial intelligence (AI) model based on multi-scale multimodal deep learning technology, integrating multi-scale CT image features and patient clinical information from multi-source heterogeneous data to predict muscle invasion of upper urinary tract urothelial carcinoma.

Methods

113 surgically-treated UTUC patients (2016-2024) were retrospectively analyzed. Tumor ROIs were segmented on CT using ITK-SNAP. 1185 stable radiomic features (ICC>0.75) were extracted via PyRadiomics. LASSO regression selected 8 predictive features (3 first-order, 5 texture). Three models (LDA, LR, SVM) were built using 10-fold cross-validation. Performance was assessed via ROC/AUC, calibration curves, and decision curve analysis.

Results

From 1185 radiomic features (ICC≥0.75), LASSO regression selected 8 predictive features (3 first-order, 5 texture) using optimal λ. All models showed good discrimination (training AUC: LDA=0.856, LR=0.858, SVM=0.856; validation AUC: LDA=0.852, LR=0.833, SVM=0.843; p>0.05). No significant differences were found between the AUC of the two models (all p-values 0.05). Decision curve analysis in the validation dataset showed that the LDA, LR, and SVM models provided almost similar overall net gains over most threshold probabilities.

Conclusions

The three predictive models we developed demonstrated robust discriminative ability for muscle invasion in both the development and validation datasets, with consistently high average AUC values. No significant differences were observed in AUC among the three models, indicating their comparable reliability in predicting muscle invasion of upper urinary tract urothelial carcinoma. The LDA model outperformed the others in the validation dataset with superior overall accuracy (76.7%), sensitivity (81.7%), and specificity (68.9%), establishing it as the optimal model. Additionally, Hosmer–Lemeshow test results confirmed excellent consistency between the predicted muscle invasion probabilities and postoperative pathological staging outcomes for all three models, achieving precise prediction of muscle invasion.

Legal entity responsible for the study

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