Maastricht University

THE D-LAB
Decision Support For Precision Medicine

Faculty of Health, Medicine and Life Sciences

Combining deep learning and radiomics for outcome prediction in radiotherapy

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Objective

Deep learning has acquired a renewed interest in the few years due to its high performance on numerous machine learning competitions. Radiomics, the high throughput extraction of imaging features from radiographic images, is known to be a viable option for prediction modelling in oncology.

In this work, we compare the performance of models that use deep learning, radiomics or a combination of deep learning and radiomics. We hypothesize that a model that combines deep learning and radiomics makes most use of the information in CT images and therefore yields the best performance. The models predict human pappilomavirus (HPV) in oropharyngeal squamous cell carcinoma (OPSCC) patients. Radiomics feature extraction is commonly done on the primary tumor volume.

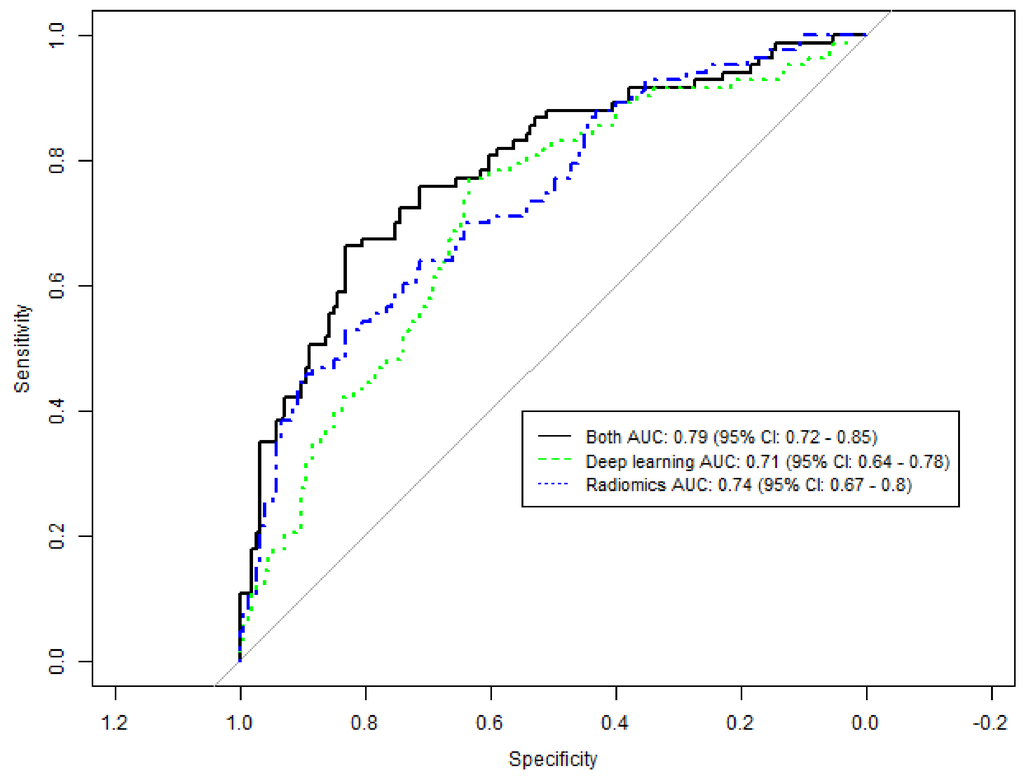
As a next step in this work, we intend to add radiomics features from positive lymph nodes to the analysis. We expect that addition of radiomics features from the lymph nodes adds additional predictive value to the model.

Methods

A total of 673 OPSCC patients were collected from the Princess Margaret Cancer Center (PMH, N=393), the VU medical center (N=179), the University Hospital Zürich (N=101). Patients were treated with curative intent radio(chemo)therapy. HPV status was determined by p16 immunohistochemistry. Models were trained on the PMH cohort and validated on remaining cohorts. Radiomics analysis and deep learning was conducted on the pre-treatment CT images of these patients. A random forest model used the radiomics features to make predictions. Performance of a model trained on radiomics features and deep learning predictions was compared to models learned on radiomics features alone and deep learning alone.

Results

The deep learning model performed with an AUC of 0.71 (95% CI: 0.64 – 0.78). The model based on radiomics features performed with an AUC of 0.74 (95% CI: 0.67 - 0.8). However, the hybrid model performed with an AUC of 0.79 (95% CI: 0.72 – 0.85), significantly higher than the radiomics ($P < 0.05$) and deep learning model ($P < 0.05$). The accuracy of the hybrid model was 0.77 (95% CI: 0.71 – 0.82).



Conclusion

A model that combines deep learning and radiomics can outperform the individual methods, indicating that there is complementary information in deep learning and radiomics features.

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