Integrating Gross Tumor Volume and Margin Features to Predict Treatment Response for Locally Advanced Rectal Cancer Patients

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JULY 12–16 2020 VIRTUAL
JOINT AAPM | COMP MEETING
EASTERN TIME [GMT-4]

PURPOSE

To investigate the effectiveness using combined gross tumor volume (GTV) and environmental margin radiomics features in predicting the treatment response after neoadjuvant chemoradiation therapy (nCRT) in patients with locally advanced rectal cancer (LARC).

BACKGROUND

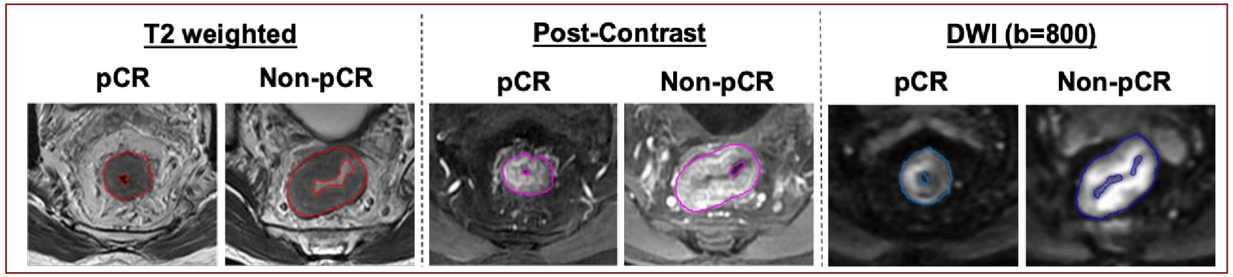
The current standard of care for patients with locally advanced rectal cancer (LARC) is neoadjuvant chemo-radiation therapy (nCRT) followed by a total mesorectal excision.

Approximately 15% of patients treated to a conventional external beam radiation dose of 50.4Gy exhibit a pathological complete response (PCR) to the nCRT. The PCR rate can be increased to 21% for patients treated to 60Gy, and further to 50% for patients treated to 90Gy with a combination of external beam and brachytherapy.

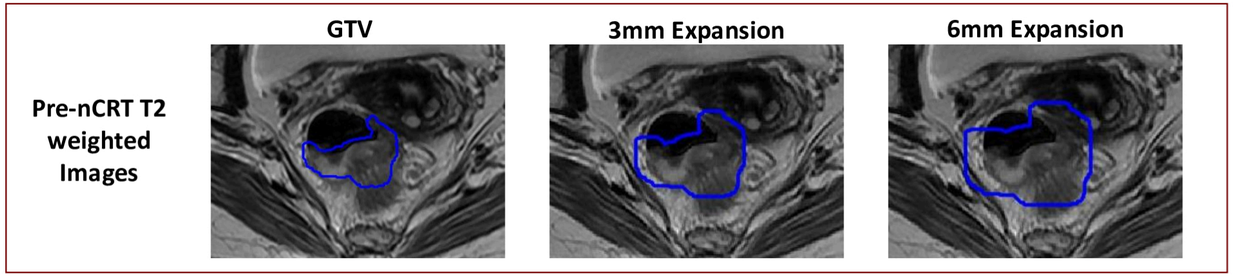
Investigators have proposed that patients with a PCR may forgo the TME surgery, as it is associated with severe morbidity and complications, and instead be treated with a sphincter saving local excision, or no surgery at all with the "wait-and-watch" policy.

For this reason, **there is a great clinical interest in finding non-invasive methods to predict PCR in patients at a pre-surgical stage.** Radiomics from pre-treatment MRI images have been evaluated with good results. In this paper, we propose that the microenvironment surrounding the tissue may provide additional information for prediction of prognosis. In this study, we hope to determine if adding a margin to the GTV for feature calculation improves the performance of the models created from those features.

METHODS



Two case examples with pre-CRT imaging. Both were 60 year old males with mid-rectum tumors, staged T3NbM0. After nCRT, one patient exhibited a PCR while the other did not. No significant differences were observed from qualitative visual inspection. The images displayed are T2-weighted, post contrast at third phase LAVA (60s after injection of contrast agent), and diffusion weighted imaging with b=800.



A case example of a pre-CRT T2-2 MRI contoured for GTV, 3mm periphery of GTV, and 6 mm periphery of GTV. Pixel size is 0.4883 x 0.4883 mm, resulting in expansions of exactly 2.9298 mm and 5.8596 mm, respectively.

Expanding on recent work investigating multi-parametric MRI radiomics in prediction of treatment response, this study evaluates the benefit of extracting features from the primary tumor plus some amount of surrounding tissue.

- 102 patients, randomly divided in training & testing groups (3:1 ratio)
- All patients with pre-nCRT MRI (T1, T2, DWI, DCE)
- Radiomics extracted from GTV, GTV + 3mm margin and GTV + 6mm margin
- Radiomics signature developed for GTV, GTV+3mm, and GTV+6mm features to predict good responders (GR, from tumor regression grading) and pathological complete responders (PCR).
- Predictive power evaluated by area under receiver operating characteristic curve (AUC)

CONCLUSIONS

In both the prediction of good responders and pathological complete responders, the best models were based on features from the gross tumor volume with a 3mm expansion. This suggests the importance of including environmental information for radiomics analysis. The models based on features from gross tumor volume with a 6mm expansion did not show improved performance when compared to the models based on GTV features. This tells us that while including environmental information can improve the predictive power of radiomics models, the optimal amount of peripheral information to be included warrants further investigation.

As we move forward with this project, we hope to not only determine the optimal amount of tumor periphery to include for feature calculation, but also the optimal method for GTV expansion. With a mathematical expansion, used in this stage of the study, some tissue included may provide information, while others are not related to the tumor. In future steps of this study, irregular expansion limited to the mesorectum will be considered.

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