Development of parameters for describing anatomical changes and predicting radiotherapy replanning for head and neck cancer patients

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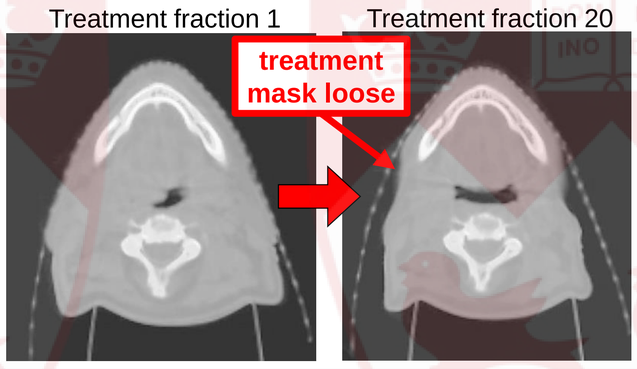
INTRODUCTION AND RESEARCH GOAL

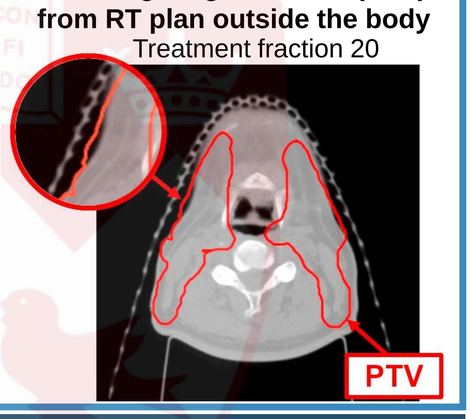
Radiotherapy (RT) treatment plans in the head and neck (HN) area are prone to being **replanned** due to anatomical changes that **invalidate the first plan** [1]. However, there is no standard method to define the amount of change to replan and when it is needed. Additionally, **replanning is resource-intensive** and usually delayed [2].

We aim identify which patients would likely need to be replanned by **defining geometrical parameters that can describe anatomical changes** and **developing a machine learning (ML) model based on the created parameters and clinical information.**

HN patients experience prominent weight loss

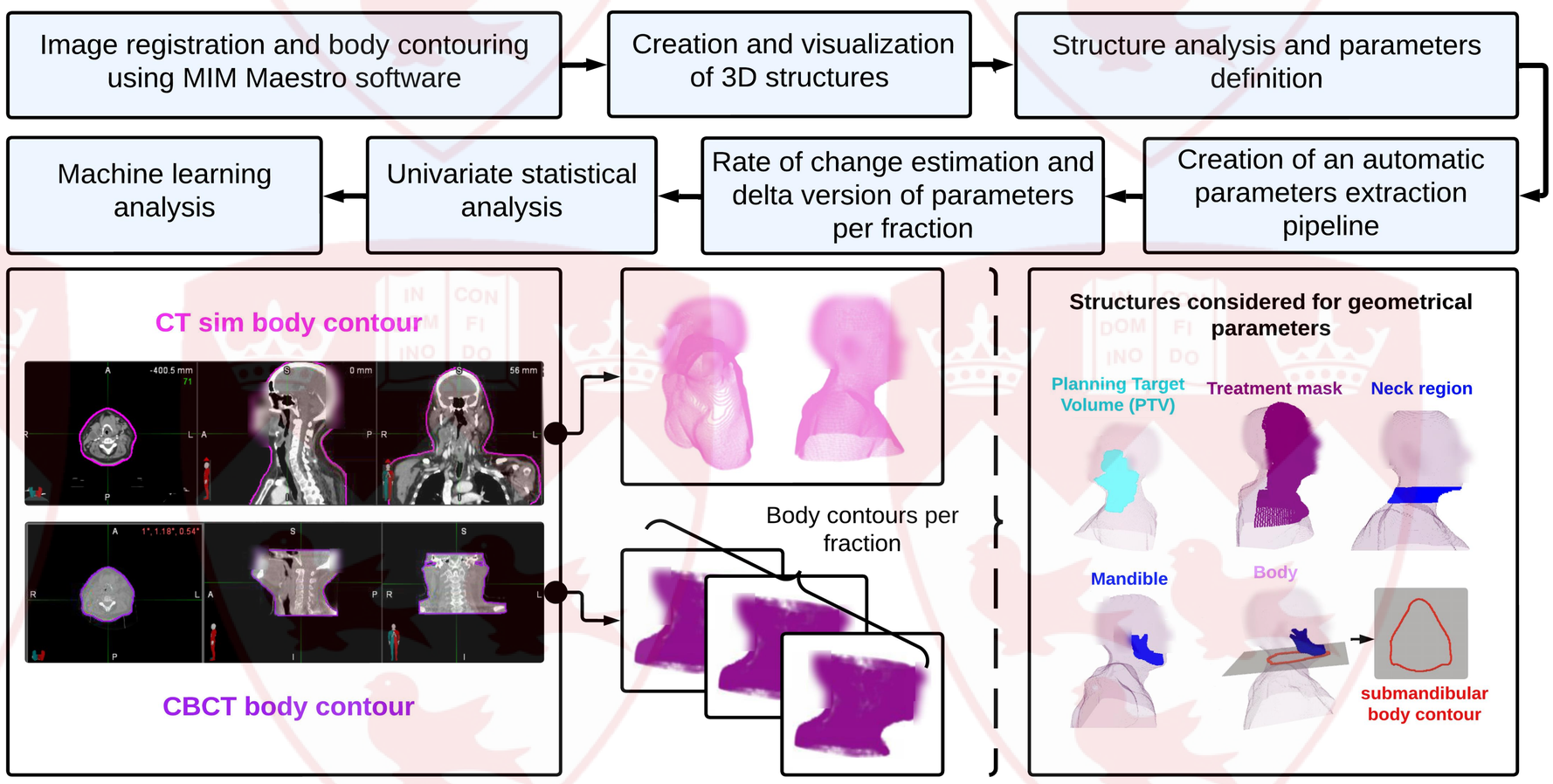


Planning Target Volume (PTV) from RT plan outside the body

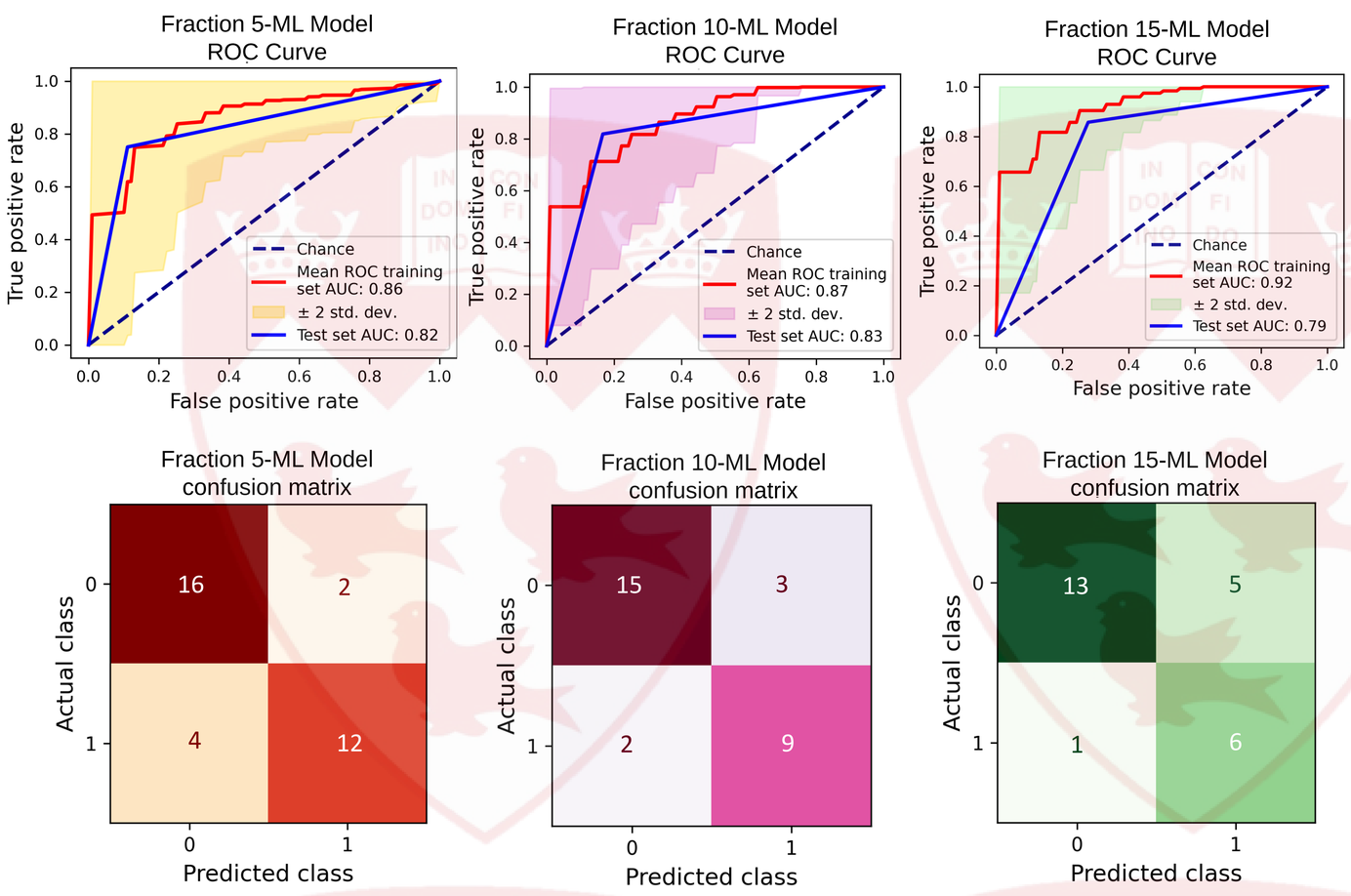


MATERIALS AND METHODS

- We included 120 HN patients treated at the McGill University Health Centre: **60 replanned patients (class 1)** and **60 non-replanned patients (class 0).**
- This retrospective study included clinical information such as weights, TNM stage, age, and smoking history.
- **43 geometrical parameters** were created to describe the patients' shape and anatomical changes.
- Three fraction-specific ML models were built to evaluate early prediction for replanning at **fractions (fx): 5, 10, and 15.**
- The dataset was split into training and testing sets (70%/30%). Performance evaluation was done using Repeated Stratified 5-Fold.



RESULTS AND DISCUSSION



- Previous research has shown that **anatomical variations begin** to appear during the **1st week of RT,** persist during the treatment and trigger replanning [3]. Our models evaluated predictions for the 1st, 2nd, and 3rd week of RT, considering the information up to each week.
- **The fx 5-ML model was able to predict** 12 out of 16 patients with an actual request replan at fx 5 or later. **False negative cases** correspond to fxs 8, 13, 15, and 20. The fx 15 and 20 cases, were identified by the fx 10-model.
- **The fx 10-ML model was able to predict** 9 out of 11 patients with an actual replan request at fx 10 or later. The model was not able to predict 2 patients: 1 case with request at fx 10 and 1 at fx 13.
- **The fx 15-ML model was able to predict** 6 out of 7 patients with a request replan at fx 15 or later. It was not able to predict 1 case that had a request at fx 15.

We were able to perform **early prediction on 75%** of our test replanned patients whose requests occurred at 1st week of treatment or later.

CONCLUSIONS AND FUTURE WORK

- The created ML models based on geometrical parameters offer promising potential to predict if patients would likely need replanning, which is important in the clinical workflow for resource management, as many patients may be identified and replanned late.
- However, a larger sample for a more comprehensive analysis is needed, which will improve the representation of cases and the ML models.
- A further analysis needs to be done to deal with false positive and false negative cases.

REFERENCES

[1] Morgan, H.E., Sher, D.J. Adaptive radiotherapy for head and neck cancer. Cancers Head Neck 5, 1 (2020).
[2] Heukelom J, Fuller CD. Head and Neck Cancer Adaptive Radiation Therapy (ART): Conceptual Considerations for the Informed Clinician. Semin Radiat Oncol. (2019).
[3] Delaby, N. et al. Practical and technical key challenges in head and neck adaptive radiotherapy: The GORTEC point of view. Physica medica. (2023).

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