AI powered decision making process for RT re-planning

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Purpose/Objective:
In radiotherapy (RT) planning, the reference planning CT (pCT) scan is used to predict the radiation doses absorbed in the patient body. Nevertheless, patient anatomical changes during treatment can affect the accuracy of the delivered doses. Daily Cone-Beam CT (CBCT) scans are used for patient positioning verification. When significant changes in anatomy are observed, to ensure no negative impact for the treatment, a new CT scan (CT2) can be performed. Subsequently, the treatment plan is updated to account for the anatomical modifications. This study aims to introduce a standardized process for re-planning through the implementation of a new offline adaptive workflow, with a focus on pelvic RT.

Material/Methods:
A retrospective statistical analysis was conducted on 20 pelvis cases of RT re-planning. Using Monaco Treatment Planning System (Elekta AB, Stockholm, Sweden), a new treatment plan calculation was performed on the CT2 scan while maintaining the fluence data/map from the pCT dosimetry. This calculation simulated a treatment session, accounting for the patient's morphological changes at the time of the CT2 scan. Additionally, adjustments to the CT2 isocenter were considered. Metrics extracted from the Dose-Volume Histogram (DVH) were compared for Organs-At Risk (OAR) and the Planning Target Volume (PTV) to assess the usefulness and justification of replanning.

In a second part of the study, the same patients were analyzed using the new AI- based tool (AdaptBox module in ART-Plan®). Synthetic CTs (sCT) were created from the daily CBCT scans and the same RTDoses were computed on both pCT and daily sCT using a Collapsed-Cone algorithm. The two RTDoses were compared and an alert based on personalized triggers (differences in volume and DVH metrics) was used to assess the need of replanning (Figure 1).

Results:

The average deviation in irradiated volume to the PTV at 95% of the prescribed dose was 8.31% for the cases where replanning was decided necessary based on the violation of the clinical constraints (see Table 1).

On the other hand, an average deviation of 1.01% to V95% to the PTV was observed for the cases where re-planning decision was finally deemed not necessary. The doses calculated on CT2 were within the clinical dose constraints for both PTV and OARs volumes.

By performing the comparison between doses calculated on pCT vs synCT within the AdaptBox module, it was observed that for 10 cases, the decision of replanning was unnecessary, for 7 cases the need of a CT2 was confirmed and for 2 cases the necessity of re-planning was subject to discussion with the physicians. Finally these conclusions were in full agreement/accordance with the previous results where doses were evaluated on the CT2 scan. Hence, by using AdaptBox, both the necessary and the unnecessary CT2 scans were correctly identified.

Decision	Clinical constraints	pCT	CT2	% diff (pCT-CT2)/pCT
Re-planning necessary	V95%>95%	97.84%	89.69%	8.31%
Re-planning not necessary	V95%>95%	97.80%	96.81%	1.01%

Table 1. Difference in DVH parameters on PTV between doses calculated on pCT and CT2

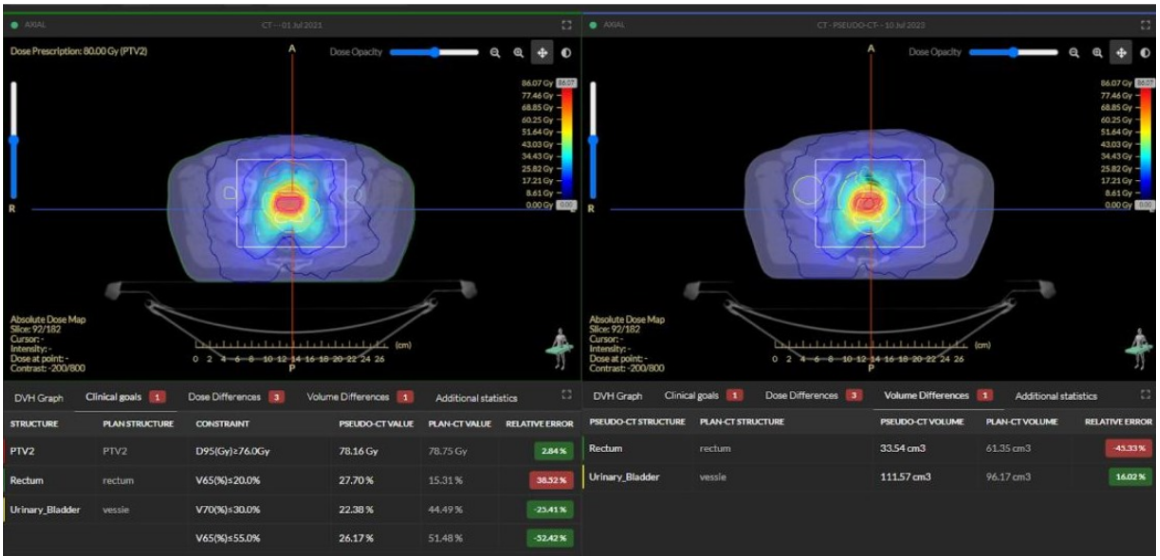

Figure 1: Example of one treatment fraction evaluated using AdaptBox. On the left, the dose calculated on the planning CT; on the right, the dose calculated on the synthetic CT.

Conclusion:

In conclusion, the number of secondary planning CT scans performed were unjustified in 50% of the cases. AdaptBox proved to be an effective tool to assist physicians and physicists in the decision making process for re-planning.