Title: Online assessment of dose changes in radiotherapy of head and neck cancer patients for initiating plan adaptation using daily cone beam CT.

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Structured Abstract:

Background: Head and neck cancer is commonly treated with radiation therapy, but due to possible drastic volume changes may require plan adaptation during a course of treatment. Unfortunately plan adaptation can consume significant clinical resources, interrupt treatment and affect treatment outcomes negatively if not performed when needed. Our objective is to explore using the deformable image registration (DIR) between the planning CT and daily cone beam CT (CBCT) studies with the planned dose distribution to quantitatively assess the necessity of plan adaptation during treatment.

Methods: This study involved 18 head-and-neck cases treated with image guided radiation therapy using CBCT who had their treatment plan modified on day X based on an additional CT study (ReCT). Assessment of daily dose changes required using DIR mapping the planned to daily anatomy and a daily dose distribution. Three different DIR's were produced between three unique pairs of image studies; i) planning CT - day X CBCT ii) day one CBCT - day X CBCT and iii) planning CT - ReCT. Two daily dose distributions computed on the planning CT and ReCT were used and rigidly registered to the secondary image. All dose calculations were performed using the Pinnacle treatment planning system and image registration was done using the software MIM vista. Using each image pair and dose distribution separately yielded 6 separate methods, with planning CT - ReCT using the ReCT dose as the gold standard. Dose changes initiating plan adaptation were measured for the parotid glands and planning target volume (PTV). Direct comparison with the gold standard was measured using relative voxel-by-voxel dose differences for the ipsilateral and contralateral parotid glands.

Results: Compared to the gold standard, the best results were produced using the planning CT to day X CBCT using the ReCT dose distribution with a relative voxel wise dose error of 7% and 8% for the ipsilateral and contralateral parotid respectively. The simplest method of planning CT to day X CBCT with the planned dose yielded a relative voxel-wise dose error of 13% and 16% for the ipsilateral and contralateral parotid respectively. All 18 patients were adapted clinically but only 8 were outside of clinical tolerances for the parotids and PTV, demonstrated by the gold standard. Using the fastest method of planning CT to day X CBCT with the planned dose would have avoided 10 unnecessary adaptations but incorrectly continued treatments of two patients.

Conclusion: We have shown that using a daily CBCT in place of a ReCT for assessing dose changes is achievable even without performing a new dose calculation and could prevent needless plan adaptations.