Clinical experience of implementing an adaptive treatment decision-making pathway for lung and H&N radiotherapy

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Introduction

- During radiotherapy, anatomical changes such as weight loss or tumour shrinkage can compromise treatment accuracy, risking healthy tissue toxicity or tumour under-dosing. In this case we provide adaptive radiotherapy assessments to assess whether the patients requires a replan.
- This work utilises on-treatment cone-beam CT (CBCT) images, a type of synthetic CT (sCT) enhanced using the treatment planning system tools to create "Corrected CBCTs" [1].
- This allows for accurate dose recalculation based on the patient's current anatomy.

Aims

1. To evaluate the clinical feasibility of the Corrected CBCTs to quantitatively assess anatomical changes in lung and head and neck (H&N) patients
2. To integrate Corrected CBCTs into our clinical pathway.

Methods

Part 1 – Anatomical & Dosimetric Accuracy

- The Corrected CBCT (cCBCT) works by removing low frequency artefacts and applies CT-HU intensity values whilst preserving the anatomy on the CBCT.
- Anatomical accuracy was assessed visually to ensure the CBCT anatomy was retained.
- Dosimetric assessment was performed using percentage difference calculations and assessing relevant clinical goals.
- This was tested on 11 lung and 15 H&N retrospective patients of varying fractionations and anatomy, enabling their use to make adaptive decisions.

Part 2 – Pipeline Details

- A flow chart of the clinical pipeline is shown in Figure 1.
- Specific steps for how the pipeline was carried for lung and H&N patients is shown in Figure 2.

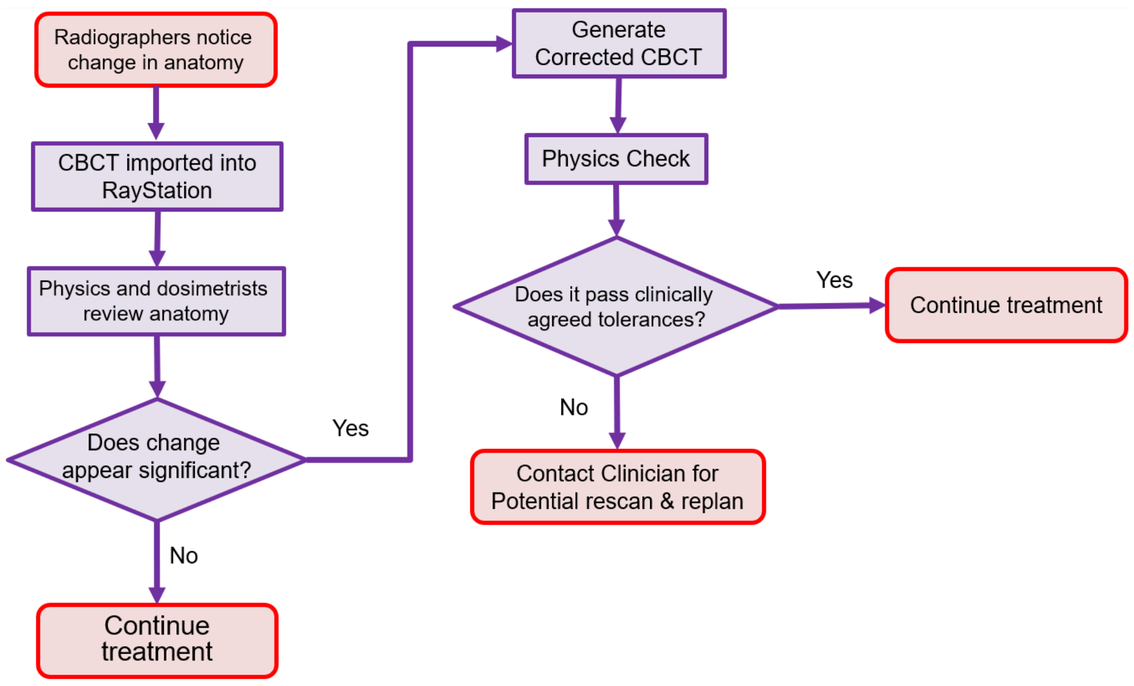

Figure 1: Flowchart of wider patient pathway for ART decision making.

Part 3 – Implementation Assessment

- The frequency of rescans and ART assessments was recorded for 1 year before commissioning (10/3/24-1-09/3/25) and 1 year afterwards (10/3/25-09/3/26), analysing the results in lungs only.
- This was not recorded for H&N patients as the treatment planning technique was altered during this time so would cause bias.

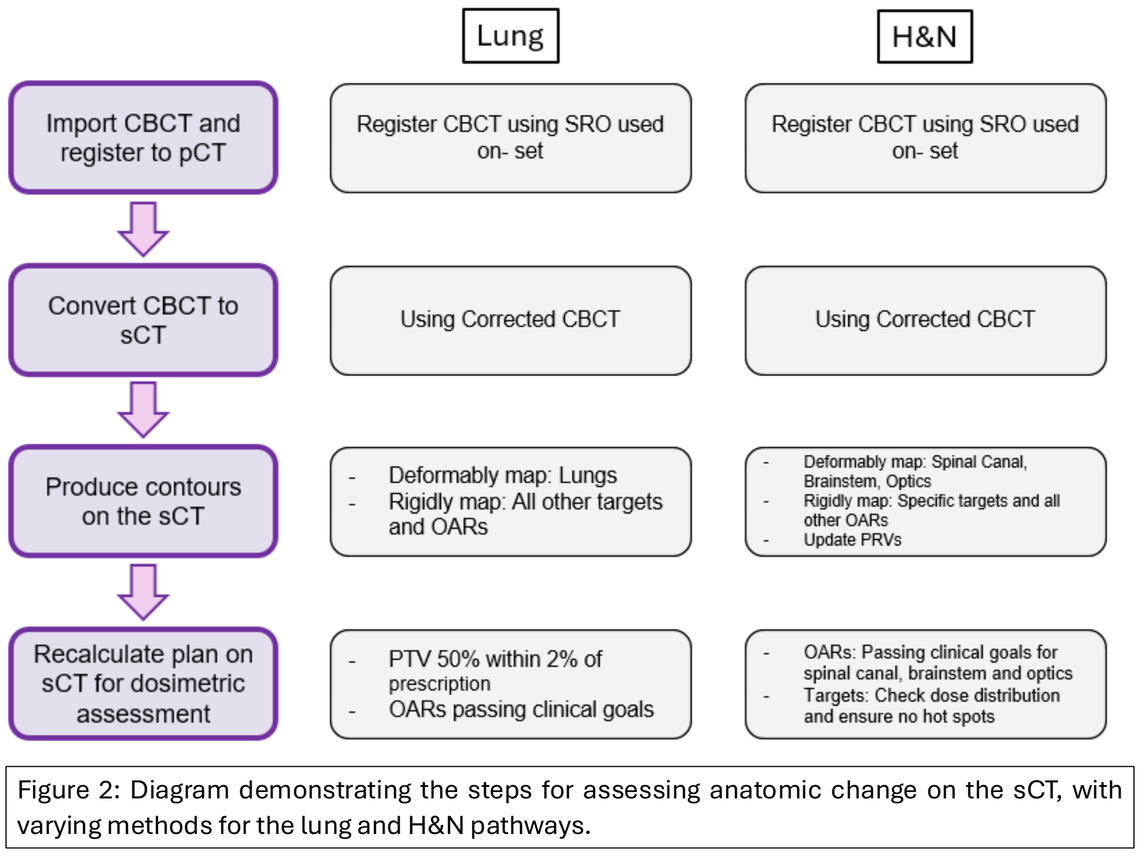

Figure 2: Diagram demonstrating the steps for assessing anatomic change on the sCT, with varying methods for the lung and H&N pathways.

Results

- Visual assessment showed no clinically significant differences, with the cCBCT being anatomically the same as the CBCT.
- Dosimetric assessment showed all differences were within ≤2% for lungs and ≤1% H&N.
- Due to the limited field of view (FOV) of the CBCTs, the current clinical pathway cannot be used H&N patients for dosimetric changes in the shoulder/nodal region (Figure 3).
- Figure 4 shows the results from the implementation assessment.
- 23 patients required a replan 1 year pre-commissioning compared with 19 patients post-commissioning, suggesting the new method may be adding confidence to the robustness of the planning techniques to anatomical changes.
- A larger proportion of the rescanned patients had ART assessments during their treatment (34.8% vs 57.9%) suggesting more informed decision making being a part of patients adaptive treatments.

Figure 3: Image showing the CBCT FOV (orange) overlayed on the pCT (blue) showing why the pathway is not used for patients with involvement in nodal regions.

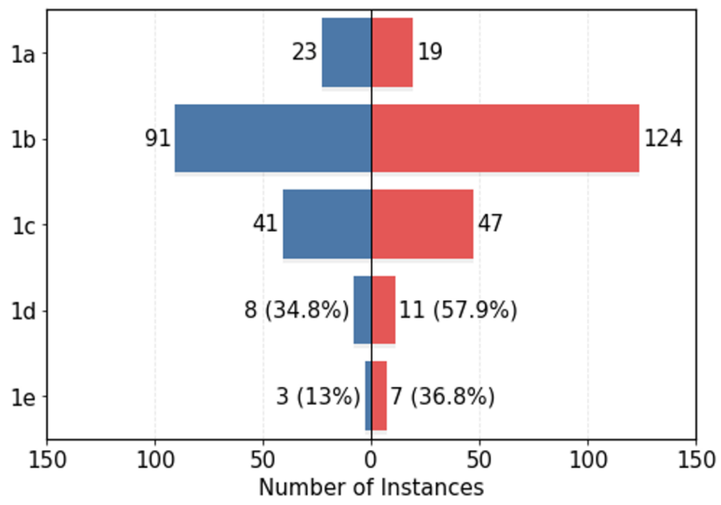

Figure 4: Diverging bar chart demonstrating for 1-year pre- and post- commissioning, (1a) the number of lung rescans (1b) the total number of ART assessments across all sites, (1c) the number of lung ART assessments, (1d) the number of lung rescans that had an ART assessment at any fraction, (1e) the number of lung rescans with an ART that resulted in the rescan.

Conclusions

- This work demonstrated the feasibility of implementing of a CBCT-based ART assessment pathway in a large radiotherapy centre.
- The proportion of lung rescan patients receiving ART over the course of their treatment has increased.
- It provided insight into the challenges and considerations that are needed for clinical implementation.

References

[1] Synthetic CT generation in raystation for enhanced workflows in adaptive radiotherapy, RayStation WhitePaper, https://www.raysearchlabs.com/siteassets/media/publications/white-papers/wp-pdfs/synthetic_ct_whitepaper.pdf

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