A Fully-Automated Field-in-Field Algorithm for Rectal Cancer
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Introduction
• The most common treatment technique for rectal radiotherapy is three-dimensional conformal radiotherapy (3DCRT).1,2
• In our clinic, a 3DCRT plan typically uses 3-field geometry consisting of a posterior-anterior (PA) beam and two opposed laterals.
• Due to asymmetries in human anatomy in the anterior-posterior direction, hotspots occur in the posterior region of the body.
• To circumvent this, hotspot reduction planning technique such as field-in-field (FiF) has been routinely used in clinic. However, the process is repetitive and time-consuming.

Aim
• Develop an algorithm to automatically produce 3D conformal radiotherapy treatment plans for rectal patient.
• The algorithm can reduce hotspots while maintaining adequate and homogeneous dose coverage to target volume using wedge and FiF technique.
• The algorithm should be customizable to changes in clinical practices and independent of treatment planning system.
• Automatically generated plans will be scored as clinically acceptable by a radiation oncologist.

Methods
• We created an algorithm using Python that automates the clinical workflow for creating plans with wedges and FiFs.
• As shown in Figure 1, the algorithm automatically identifies a hotspot volume, creates a subfield, calculates dose, and optimizes beam weight without user intervention. This process is repeated until the hotspot is sufficiently reduced.
• The following planning metrics were recorded before and after FiF algorithm for comparison: percentage V107 hotspot and hotspot percentage. Physician evaluation and scoring followed 5-point scale (Table 2).

Results
• For each patient, at least one plan was acceptable.
• The best performing configuration was B for most patients with 85% acceptability.

Conclusion
We have automated the clinical workflow for generating FiF to reduce hotspots in 3-field 3D conformal plans for rectal cancer.

References

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Figure 1: The flow chart of the FiF algorithm. The green and yellow boxes indicate steps performed in treatment planning system (TPS) and FiF algorithm, respectively.

Table 1: shows different configurations tested on 20 rectal patients treated with 3-field 3DCRT. All plans were normalized so that 99% of the PTV was covered with the prescription dose.

Table 2: Scoring rubrics

Figure 2: Top row: Boxplots for volume exceeding 107%Rx for (top left) different hotspot percentage settings, and (top right) different wedge settings. Bottom row: Boxplots for percentage hotspot dose of plans before and after FiF for (bottom left) different hotspot percentage settings, and (bottom right) different wedge settings.

Table 3: The results of physician review for each configuration