

Prostate volume changes during longer fractionated and ultra-hypofractionated MR-guided adaptive radiotherapy leveraging the MOMENTUM registry

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Purpose/Objectives

Prostate volume changes during radiotherapy may compromise target coverage [1,2]. We quantified longitudinal swelling across longer fractionation (≥ 15 fractions)(LFRT) [3] and stereotactic body radiotherapy (SBRT) regimes during MR-guided adaptive radiotherapy (MRgART) to identify predictors of clinically significant swelling (CSS, defined as $\geq 15\%$ volume increase) [4,5].

Materials/Methods

This multicentre prospective cohort study analysed patients treated on an MR-Linac between January 2020-April 2025 enrolled in MOMENTUM [6]. Inclusion mandated daily recontouring/adaptation with ≥ 3 fractions available. Structure volumes were extracted using PyRadiomics (v3.0.1). A hierarchical fuzzy-matching algorithm (Levenshtein distance) harmonised prostate volume nomenclature across centres. Clinical and demographic variables were collected, and fraction 1 counted as baseline volume [7]. Proportion of treatment spent with CSS was normalised to number of fractions. Baseline prostate volume was dichotomised. Linear mixed-effects models (LMM) quantified continuous volume trajectories by cohort. Multivariable logistic regression tested predictors of CSS as a binary outcome.

Results

From 1907 patients, 222 LFRT and 1390 SBRT patients met eligibility. A total of 10297 fractions were analysed (median 20 for LFRT, 5 for SBRT patients), with median baseline prostate volume of 40.0 cm^3 (IQR 28.9-53.6) for LFRT and 47.5 cm^3 (IQR 35.8-66.0) for SBRT. Incomplete age data excluded 160 patients from LMM. CSS occurred in 15.2% LFRT and 13.1% SBRT total fractions (figure 1), but SBRT patients spend a higher proportion of treatment in CSS (figure 2). In LMM, larger baseline prostate volume was associated with reduced mean swelling in SBRT ($\beta = -0.030\%$ per cm^3 , $p < 0.001$) but not LFRT ($p = 0.30$). However, logistic regression showed larger baseline volume was protective in both cohorts (LFRT: OR 0.38, 95% CI 0.32-0.46; SBRT: OR 0.80, 95% CI 0.69-0.92). In secondary complete-case analysis including ADT and T-stage data ($n = 116$ LFRT, $n = 256$ SBRT), no significant association with ADT was observed in either cohort (LFRT $p = 0.65$; SBRT $p = 0.37$), whilst T2-stage disease was associated with increased swelling in SBRT ($\beta = +3.0\%$, $p = 0.018$) compared to T1-stage.

Conclusion

SBRT patients experience a faster onset of prostate swelling compared to LFRT. Smaller baseline volumes and T2-stage was associated with increased swelling risk. Incomplete clinical covariate data limits definitive risk stratification, supporting continued fraction-by-fraction adaptive workflows.

Figure1: Percentage change from baseline, disaggregated by fractionation group, with the horizontal red line showing the 15% threshold for swelling

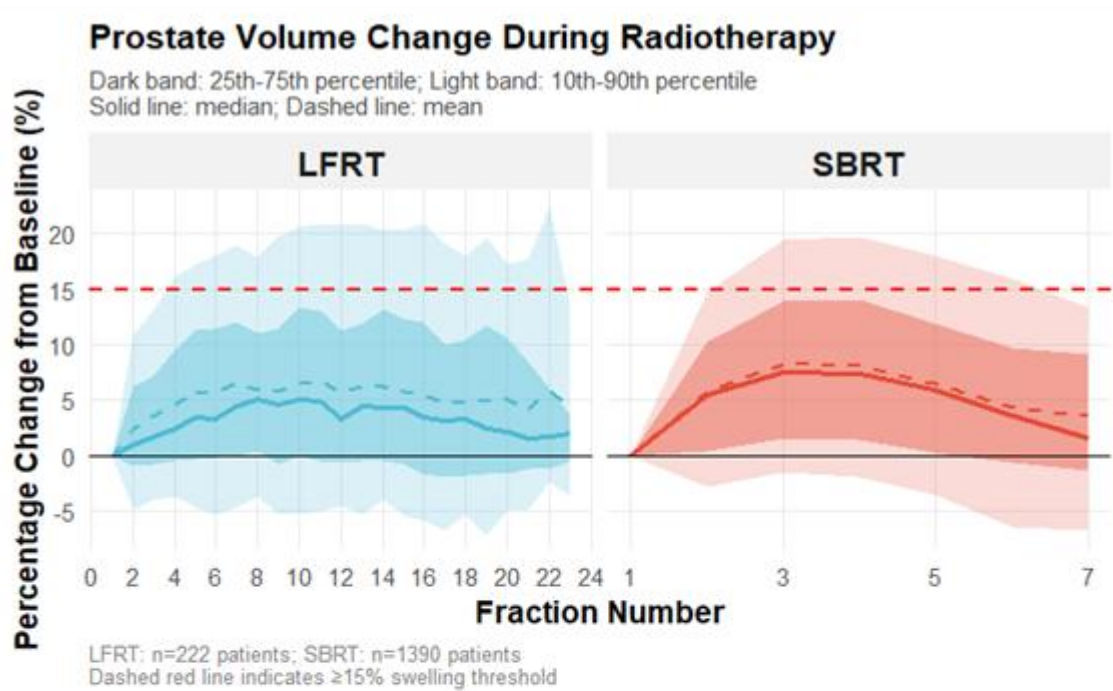


Figure 2: Proportion of treatment spent in clinically significant swelling ($>15\%$)

