Ultra-Hypofractionated Radiation Therapy treatment to whole-breast for early-stage breast cancer: Optimal standard of care

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Purpose: Radiation therapy is utilized as an adjuvant treatment after breast conserving surgery in early-stage breast cancer patients. There are several protocols available for management of early-stage breast cancer. The purpose of the study is to present a dosimetric narrative of ultra-hypofractionated (Fast-Forward) and moderate hypofractionated (Fast) treatment regimen. A well established method of treatment delivers 4256cGy in 16 fractions approximately over 3 weeks, which has been proven to work as well as longer conventionally fractioned treatment schedules. Recently, even shorter treatment regimens delivering 2600cGy over 5 fractions in one week has been shown to be as effective and safe as moderately hypofractionated treatment schedules.

Methods: This study includes 30 Left sided supine breast cases. The review compares radiation dose distribution plans from patients treated with 266cGy per fraction for 16 fractions (hypofractionated) and 520cGy per fraction for 5 fractions (ultra-hypofractionated) using same planning target volume (PTV)_Left Breast. Radiation treatment plans utilize 6x beam energy with 3-dimensional tangent beams using field-in-field technique.

Results: Outcome demonstrated that the dose distribution in isodose lines representation remains similar. PTV coverage was slightly reduced due to acceptance of lower hot-spot for fast forward treatment plans. Dose Volume Histogram (DVH) values were analyzed, and Normal Tissue Complication Probability (NTCP) were calculated based on mathematical model. Model results indicated that biologically effective dose is comparable for heart and lung for both treatment plan schedules. NTCP results were very small and as low as 1%, making them insignificant.

Conclusion: The review suggests that the Ultra-hypo-fractioned radiation therapy plan using 520cGy for 5 fractions offers similar and safe dosimetric results compared to 266cGy for 16 fractions treatment schedule. Despite the fact that 16-fraction schedule has longer follow-up data, the 5-fraction schedule is a safe option available to patients offering reduced treatment duration.

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INTRODUCTION

Radiation therapy is commonly used as an adjuvant treatment following breast-conserving surgery in patients with early-stage breast cancer. Several fractionation protocols are available for the management of this population.

Standard dose regimens for whole-breast irradiation include:

5000 cGy in 25 fractions (200 cGy per fraction)
4256 cGy in 16 fractions (266 cGy per fraction)
4000 cGy in 15 fractions (267 cGy per fraction)
2600 cGy in 5 fractions (520 cGy per fraction; newer UK trials)

The primary goal of radiation therapy is to reduce the risk of local recurrence in the breast following surgical intervention. This study aims to present a dosimetric comparison between ultra-hypo-fractionated (FAST-Forward) [1, 2] and moderately hypofractionated (FAST) treatment regimens.

The FAST regimen, a well-established approach, delivers 4256 cGy in 16 fractions over approximately three weeks and has been shown to be as effective as conventional, longer fractionation schedules. More recently, the FAST-Forward regimen—delivering 2600 cGy in 5 fractions over one week—has demonstrated comparable efficacy and safety to moderately hypofractionated schedules.

The FAST-Forward trial [3] showed that a one-week course of radiation therapy is non-inferior to the traditional three-week schedule in terms of tumor control and late normal tissue effects. Supporting commentary by Lewis et al. [4] further emphasized the clinical applicability of these findings, highlighting both improved patient convenience and increased healthcare efficiency. The adoption of the FAST-Forward regimen across the UK demonstrates that breast cancer radiotherapy can be delivered effectively and safely over a one-week period instead of three weeks [5, 6].

METHODS AND MATERIALS

This study includes 30 left-sided breast cancer cases treated in the supine position. It compares radiation dose distribution plans for patients receiving 266 cGy per fraction over 16 fractions (FAST) and 520 cGy per fraction over 5 fractions (FAST-Forward), using the same planning target volume (PTV) for the left breast.

All radiation treatment plans were generated in Varian Eclipse TPS using 6 MV photon beam energy with 3D tangential beams and a field-in-field technique.

Dose Volume Histogram (DVH) data of PTV and organs at risk were anonymized and exported from the Eclipse TPS. Software was developed to import the DVH and calculate the Normal Tissue Complication Probability (NTCP) values for different critical organs using the Poisson model of cell killing proposed by Zaider et al [7].

RESULTS

The results demonstrate that ultra-hypofractionated radiation therapy provides outcomes comparable to those of standard hypofractionation. When comparing the two (FAST and FAST-Forward) treatment schedules, the overall dose distribution across the breast remains consistent, as reflected by similar isodose patterns (Figure 1). Although a slight reduction in planning target volume (PTV) coverage was observed in the 5-fraction regimen, this was anticipated due to the acceptance of lower hotspot levels during planning and does not significantly compromise plan quality.

Analysis of the dose–volume histograms (DVHs) showed that critical organs, including the heart and lung, received nearly identical radiation doses across both treatment regimens (Figure 2). Most normal tissue complication probability (NTCP) values were extremely low (approaching 0%), as shown in Figure 3. A small increase was observed in one case (approximately 0.7%), particularly with the field-in-field technique. Overall, all plans remained well below clinically significant thresholds, with only one case approaching 1% NTCP for the left lung, which is still considered negligible.

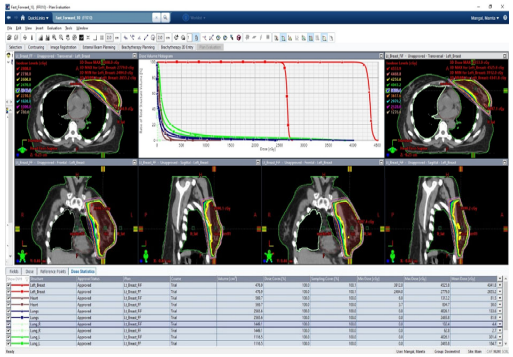

Figure 1. Plan comparison between FAST-Forward (520 cGy × 5) and FAST (266 cGy × 16) regimens.

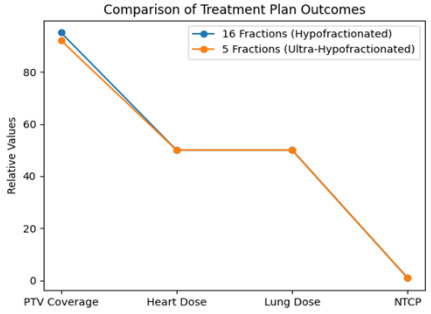

Figure 2. Comparison of PTV coverage, doses to critical organs (heart and lung), and NTCP between the FAST-Forward (520 cGy × 5) and FAST (266 cGy × 16) regimens.

DISCUSSION

Dose distribution is particularly important in left-sided breast cancer, where minimizing radiation exposure to the heart is critical. The comparison of relative doses shown in Figure 2 demonstrates that the risk of side effects and damage to healthy tissue is minimal and comparable between the two treatment approaches. Furthermore, the NTCP comparison in Figure 3 suggests that the shorter treatment schedule does not increase the risk to critical organs, particularly the heart.

CONCLUSIONS

This study suggests that ultra-hypofractionated radiation therapy, delivered as 520 cGy for 5 fractions, provides dosimetric results that are comparable to and as safe as the 266 cGy for 16 fractions regimen. Although the 16-fraction schedule has longer follow-up data, the 5-fraction regimen represents a safe alternative that offers the advantage of a shorter treatment duration for patients.

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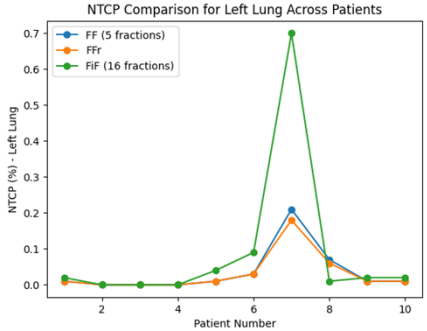

Figure 3. Comparison of NTCP for each patient across the FAST-Forward (FF, 520 cGy × 5), dose-capped FAST-Forward (FFr, maximum dose limited to 105%), and FAST (FiF, 266 cGy × 16) regimens.